DEPARTMENT OF ENERGY

The pattern of energy use in the UK—1980

R Hardcastle

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CONTENTS

		Paragraphs	Page
CONTENTS			iii
SUMMARY			v
1.	INTRODUCTION	1-10	1
2.	THE PATTERN OF ENERGY USE IN THE UK - 1980	11-146	3
	2.1 General	11-16	3
	2.2 Domestic Sector	17-26	7
	2.3 Commercial and Institutional Buildings	27-37	11
	2.4 Agriculture	38-40	19
	2.5 The Iron and Steel Industry	41-54	20
	2.6 Other Industry	55-141	26
	2.6.1 Summary	55-63	26
	2.6.2 Food, Drink and Tobacco	64-71	33
	2.6.3 Engineering and Other Metal Trades	72-86	46
	2.6.4 Textiles, Leather and Clothing	89-95	64
	2.6.5 Paper, Printing and Stationery	96-104	74
	2.6.6 Bricks, Tiles, Fireclay and Other Building Materials	105-112	80
	2.6.7 China, Earthenware and Glass	113-121	87
	2.6.8 Cement	122-125	93
	2.6.9 Chemicals and Allied Trades	126-134	97
	2.6.10 Other Trades	135-141	102
	2.7 Transport	142-146	109
3.	PRINCIPAL DATA SOURCES		112
ANNEX	THE CALCULATION OF PRIMARY FUEL EQUIVALENT OF DELIVERED ENERGY 1980		115
INDEX			138

SUMMARY

Details of the end-use of energy are presented in tabular and diagrammatic form for each of the sectors making up the aggregate UK energy consumption in 1980. ETSU Report R7, 'The Pattern of Energy Use in The UK - 1976' is used as the basis for this report but many new data have been collected and compiled for each sector and reconciled with aggregate energy usage, as reported in the Digest of United Kingdom Energy Statistics 1982.

Aggregate energy-use data are subdivided as far as possible into identifiable individual uses e.g. space heating, stationary motive power etc. and these totals are expressed on a delivered energy basis. The primary fuel equivalents of each fuel and/or energy carrier, as calculated in the Annex to the main report, are used to derive the inputs of primary fuel attributable to each purpose.

1. INTRODUCTION

1. The UK Digest of Energy Statistics, published annually by the Department of Energy, provides detailed information on the energy supplied and consumed within the UK on an aggregate basis and by individual sectors i.e. Domestic, Transport etc. It does not however, provide detailed information on the purposes for which energy is used e.g. space heating, motive power etc., within the sectors.

2. For this reason, ETSU carried out an extensive analysis of the pattern of energy end-use in the UK as part of their energy modelling and scenario assessments and presented the data compiled in ETSU Report R7 'The Pattern of Energy Use in The UK - 1976'. The Report R7 has been used extensively by individuals and institutions involved in the energy field as a basis for their energy analysis. For these reasons, the Department of Energy has commissioned this report to collect new information on the pattern of energy use for the year 1980 and modify and update the R7 analysis.

3. This report has drawn on a multitude of sources of information, kindly supplied by many people in the nationalised fuel industries, Government Departments and industrial organisations. Reference has also been made to numerous reports and documents within and outside ETSU both for the purpose of actual data collection and for cross-checking information.

4. The report is presented within the same framework as ETSU Report R7 and the information contained here is disaggregated on a similar basis to that in R7 so that comparisons and trends in energy use can be easily identified. 1980 was chosen as the base year for this report since ETSU has used and collected much information on the pattern of energy use in industry in 1980 (including the Iron and Steel Industry) in related studies. Such data were collected through discussions with individuals within and outside the industries concerned and the final results are presented in section 2.6 with each industrial sector's pattern of energy end use presented individually. The Iron and Steel Industry's energy use data are discussed and presented separately in section 2.5.

5. The totals derived have been reconciled and grossed up to accord with those presented in the Digest of UK Energy Statistics 1982 and are thus ETSU's responsibility. Unconventional fuel sources are not accounted for in the Digest of UK Energy Statistics but are included in this analysis where information is available.

6. The basis for measurement of energy consumption in the report is that of delivered energy. This is defined as the thermal content of the fuels/energy carriers delivered to the final consumer. All final consumption figures in the UK Digest of Energy Statistics are presented on this basis.

7. It could be argued that a more suitable alternative measurement to delivered energy would be 'useful heat'. This measure takes account of the differing efficiencies of each fuel/energy carrier which varies according to the fuel/energy carrier itself and the actual use to which it is put. However, because efficiencies of end use are difficult to define in some cases, e.g. transport fuels, this paper uses delivered energy as the basis of measurement.

8. Analogous to the concept of 'useful energy', described above, is that of primary fuel equivalent. By primary fuel we mean coal, oil, natural gas and nuclear/hydro electricity. The rationale for the calculation of primary fuel equivalents is that it may take more primary units of energy to produce and distribute one unit of one particular fuel/energy carrier than it does another. For example, it is estimated for 1980 that it takes approximately 3.5 times as much primary energy to produce a given amount of electrical energy, as opposed to some 1.1 times as much primary energy to produce a given amount of energy as oil.

9. The primary fuel equivalent measure thus takes account of the losses of energy during the production and distribution stages and estimates of the primary fuel equivalent are given for most end-use aggregates presented.

10. The calculation of the primary fuel equivalents of each fuel/energy carrier is described in the Annex to this report. The actual calculation is not simple because:

(a) proper allowance must be made for international trade in secondary fuel;

(b) the energy industries use each others products.

The energy used by the energy industries themselves, i.e. collieries, gas supply industry, refinery operations, other solid fuel plants, electricity generation, and coke oven operations, is not included in the analysis in Section 2.

2. THE PATTERN OF ENERGY USE IN THE UK - 1980

2.1 GENERAL

11. According to the Digest of UK Energy Statistics 1982, the United Kingdom consumed some 5,966.7 PJ of conventional, recorded fuels/energy carriers in 1980. This was the total amount of energy used by the four main consuming sectors (or direct consumers*) identified in the official statistics reported in the Digest.

12. These four sectors are: the Domestic sector, Industry, Transport and Other Final Consumers. Industry is further divided between the Iron and Steel and Other Industries while Other Final Consumers is split into Commercial and Institutional Buildings, Agriculture and the Petroleum Industry's non-refinery use of fuel.

13. Tables 1 and 2 split total UK energy consumption by fuel/energy-carrier and by sector, while Figure 1 represents these tables diagrammatically for delivered energy use.

Table 1. UK energy consumption split by fuel/energy-carrier, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Coal	538.4	554.1
Coke and breeze	166.5	209.8
Other solid fuel	63.0	80.0
Coke oven gas	26.9	76.1
Town gas	3.3	7.8
Natural gas**	1,744.1	1,846.7
Electricity	807.3	2,818 7
Petroleum	2,615.7	2,873.2
Creosote/pitch	1.5	1.8
	5,966.7	8,468.2

Table 2. UK energy consumption, split by sector, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Domestic	1,668.8	2,536.0
Commercial/institutional buildings	705.8	1,209.0
Agriculture	62.7	103.1
Iron and steel industry	302.4	464.2
Other industry	1,717.9	2,471.8
Transport	1,488.6	1,661.6
Petroleum industry (non-refinery use)	20.5	22.5
	5,966.7	8,468.2

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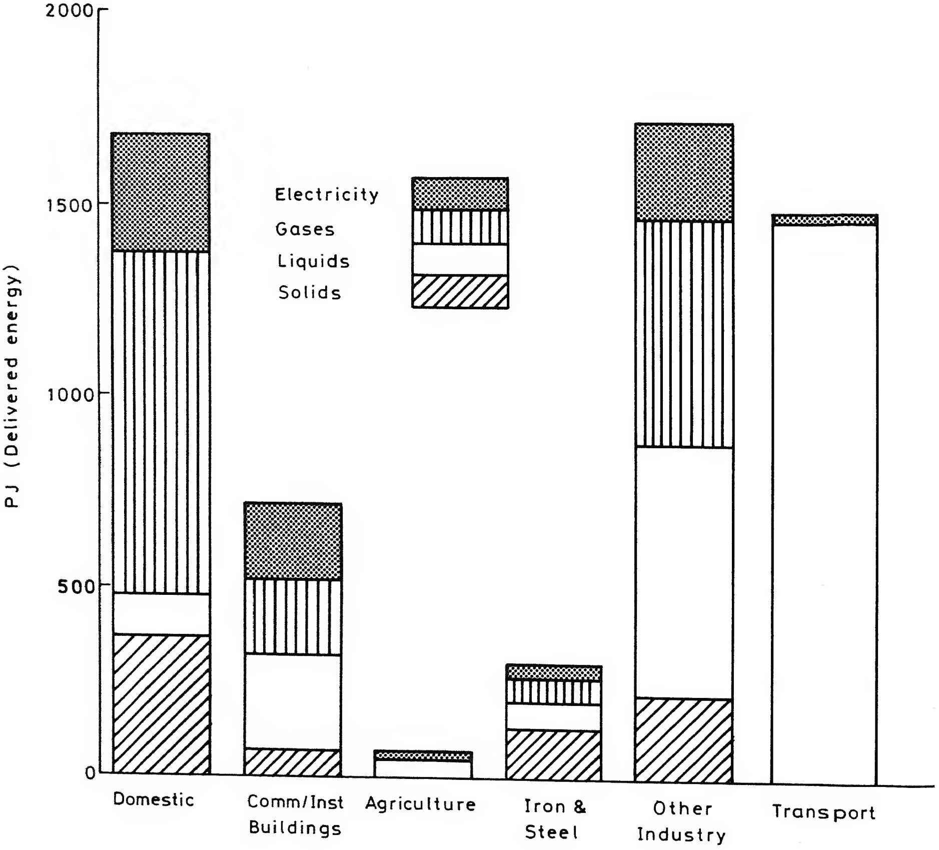
* Direct consumption refers to energy produced by the UK fuel industries, fuel supplied from stocks and imported fuels supplied to the four consuming sectors mentioned above.

** Including SNG.

2.1 General

Figure 1. Energy use in the UK split by sector and by fuel/energy-carrier, 1980



14. Table 3 presents a complete picture of energy demand in the UK for 1980: the end-use figures derived are the results of the analyses presented in sections 2.2 to 2.7. Table 4 is a summary table of the main results on end-uses obtained in this analysis. Table 5 describes the pattern of use for public supply electricity.

15. An analysis of Table 5 suggests that about 65% of total electricity use is non-substitutable. By non-substitutable, we mean uses for which there is not likely to be a suitable alternative fuel available, e.g. lighting.

Table 3. Energy Demand in the UK, 1980, PJ - Delivered Energy

Energy for Direct Consumption		Direct Consumption	
Coal	538.4	Iron & Steel Industry	4.6
		Other Industry	208.3
		Transport	1.8
		Domestic	275.4
		Comm/Inst Buildings	47.5
		Agriculture	0.8
			538.4
Coke & Breeze	166.5	Iron & Steel Industry	127.8
		Other Industry	11.9
		Transport	0.1
		Domestic	16.8
		Comm/Inst Buildings	9.7
		Agriculture	0.2
			166.5
Creosote/Pitch	1.5	Iron & Steel Industry	0.6
		Other Industry	0.9
			1.5
Other Solid Fuel	63.0	Other Industry	1.3
		Domestic	57.4
		Comm/Inst Buildings	4.3
			63.0
Coke Oven Gas	26.9	Iron & Steel Industry	19.6
		Other Industry	7.3
			26.9
Natural Gas/ SNG	1,744.1	Iron & Steel Industry	47.6
		Other Industry	591.5
		Domestic	888.4
		Comm/Inst Buildings	216.6
			1,744.1
Towns Gas	3.3	Other Industry	0.5
		Domestic	2.0
		Comm/Inst Buildings	0.8
			3.3
Liquid Petroleum Gases	57.5	Iron & Steel Industry	1.0
		Other Industry	45.1
		Domestic	11.4
			57.5
Petroleum Products	2,558.2	Iron & Steel Industry	67.9
		Other Industry	597.3
		Transport	1,475.7
		Domestic	107.3
		Comm/Inst Buildings	242.1
		Agriculture	47.4
		Petroleum Industry	20.5
			2,558.2
Electricity	807.3	Iron & Steel Industry	33.3
		Other Industry	253.8
		Transport	11.0
		Domestic	310.1
		Comm/Inst Buildings	184.8
		Agriculture	14.3
			807.3
TOTAL	5,966.7		5,966.7

Direct Consumption by Sector		Direct Consumption by End-Use		End-Use, by Fuel			
				Oil + LPG	Solids	Gases	Elec
Iron & Steel Industry	302.4	Ironmaking	167.0	21.0	128.2	13.3	4.5
		Steelmaking	12.0	-	1.6	-	10.4
		Metal Finishing	80.9	29.6	-	35.2	16.1
		Space & Water Heating	8.3	3.8	0.7	3.7	0.1
		Private Generation	23.8	12.1	2.3	9.4	-
		Others	10.4	2.4	0.2	5.6	2.2
			302.4	68.9	133.0	67.2	33.3
Other Industry	1,717.9	Process Energy:					
		Via Boilers	291.0	160.1	30.9	100.0	-
		Direct	392.7	99.3	94.8	136.3	62.3
		Motive Power	207.4	49.5	-	1.0	156.9
		Space & Water Heating	345.5	180.2	30.1	123.3	11.9
		Private Generation/CHP	303.5	137.6	63.7	102.2	-
		Feedstocks	113.2	-	-	113.2	-
		Others	64.6	15.7	2.9	23.3	22.7
			1,717.9	642.4	222.4	599.3	253.8
Transport	1,488.6	Road	1,165.0	1,165.0	-	-	-
		Rail	51.2	38.5	1.7	-	11.0
		Water	52.8	52.6	0.2	-	-
		Air	219.6	219.6	-	-	-
			1,488.6	1,475.7	1.9	-	11.0
Domestic	1,668.8	Space Heating	996.4	84.5	274.1	569.0	68.8
		Water Heating	372.1	31.9	72.2	213.4	54.6
		Cooking	143.5	2.3	3.3	106.6	31.3
		Lighting	27.3	-	-	-	27.3
		Appliances	129.5	-	-	1.4	128.1
			1,668.8	118.7	349.6	890.4	310.1
Commercial/ Institutional Buildings	705.8	Space Heating	448.9	212.7	54.1	147.2	34.9
		Water Heating	77.6	29.4	7.4	27.0	13.8
		Cooking	61.5	-	-	43.2	18.3
		Lighting	88.7	-	-	-	88.7
		Appliances	29.1	-	-	-	29.1
			705.8	242.1	61.5	217.4	184.8
Agriculture	62.7	Heating/Drying	20.5	19.2	1.0	-	0.3
		Power Units	28.2	28.2	-	-	-
		Electric Machinery	14.0	-	-	-	14.0
			62.7	47.4	1.0	-	14.3
Petroleum Industry	20.5	Non-Refinery Use	20.5	20.5	-	-	-
			20.5	20.5	-	-	-
TOTAL	5,966.7		5,966.7	2,615.7	769.4	1,774.3	807.3

2.1 General

Table 4. End uses of energy in the UK, 1980*

	Delivered Energy		Primary Fuel Equivalent	
	PJ	%	PJ	%
Low Temperature Heat (< 120°C)				
Space and water heating	2,312.9	39	2,965.8	35
Process heat	318.7	5	373.9	4
High Temperature Heat (> 120°C)				
Iron and steel industry	278.2	5	464.0	6
Other process use	610.6	10	720.3	9
Cooking	217.3	4	351.1	4
Transport Fuels				
(inc stationary engines & off-road vehicles using liquid fuels)	1,566.3	26	1,746.6	21
Non-heat Uses of Electricity	529.0	9	1,704.2	21
Natural Gas Feedstocks and Non-Refinery Use of Petroleum	133.7	2	142.3	2
	5,966.7	100	8,468.2	100

* Totals derived after allocating industrial distribution losses, and fuels for private generation/CHP over industrial end-uses.

Table 5. End uses of public supply electricity in the UK, 1980

	PJ - Delivered Energy	%
Space and water heating	184.0	23
Cooking	50.8	6
Process heat	40.6	5
Electrochemical	32.4	4
Motive Power	189.8	24
Electric traction	11.0	1
Lighting	141.1	17
Electric Appliances	157.6	20
	807.3	100

16. It must be noted that electrically-driven off-road vehicles in industry, petroleum feedstocks and other non-energy uses of petroleum products, e.g. ships' bunkers, do not enter into the above analysis. These are discussed, however, in the appropriate places in sections 2.2 to 2.7.

2.2 THE DOMESTIC SECTOR

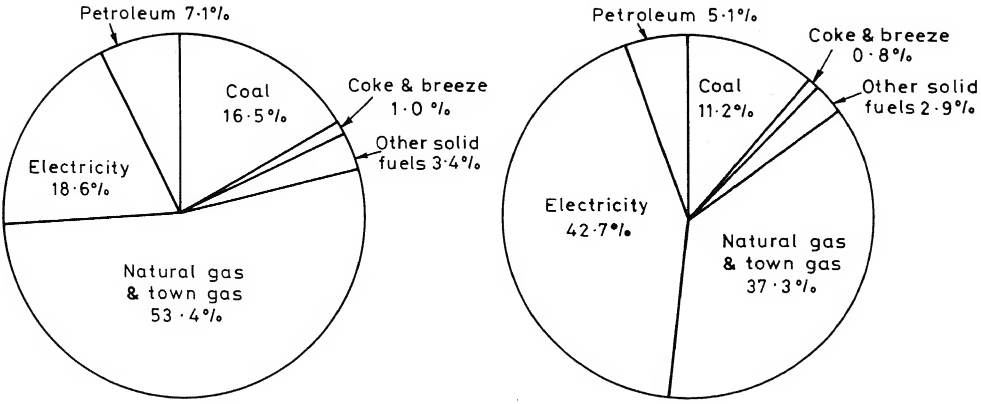
17. The domestic sector accounted for 28% of total UK energy consumption, making it the second largest aggregate energy consuming sector. Some 1668.8 PJ were consumed in 1980 by the sector.

18. Table 6 and Figure 2 show the sector's total energy consumption in 1980 split by fuel/ energy carrier.

Table 6. Energy use in the domestic sector, split by fuel/ energy-carrier, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Coal	275.4	283.4
Coke and breeze	16.8	21.2
Other solid fuel	57.4	72.9
Natural gas	888.4	940.7
Town gas	2.0	4.7
Electricity	310.1	1082.7
Petroleum	118.7	130.4
	1668.8	2536.0

Figure 2. Energy use in the domestic sector, split by fuel/ energy carrier, 1980



Delivered Energy

Primary Fuel Equivalent

2.2 Domestic Sector

19. Five identifiable end-uses of energy make up total energy use: these are space heating, water heating, lighting, cooking and appliances. Table 7 and Figure 3 show the breakdown of total energy consumed by the sector into these end-uses.

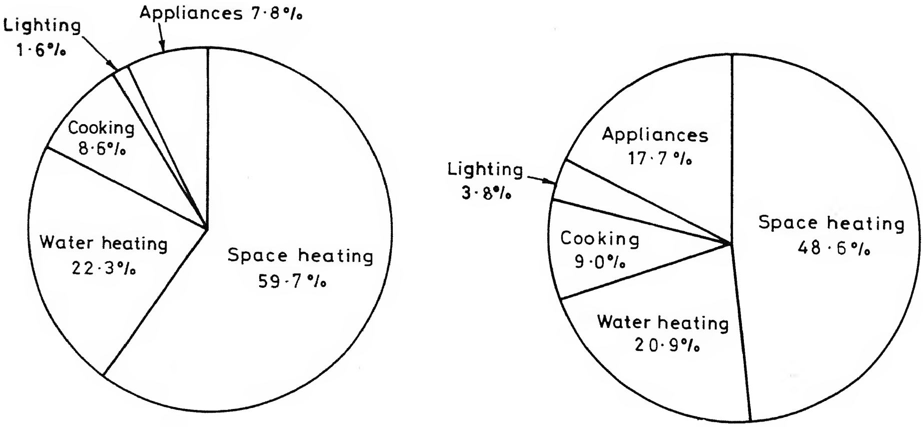
Table 7. The pattern of energy use in the domestic sector, 1980

			PJ		
Delivered Energy	Liquids	Solids	Gases	Electricity	Total
Space Heating	84.5	274.1	569.0	68.8*	996.4
Water Heating	31.9	72.2	213.4	54.6**	372.1
Cooking	2.3	3.3	106.6	31.3	143.5
Lighting	–	–	–	27.3	27.3
Appliances	–	–	1.4	128.1	129.5
	118.7	349.6	890.4	310.1	1668.8
Primary Fuel Equivalent					
Space Heating	92.9	296.0	604.2	240.2	1233.3
Water Heating	35.0	78.0	226.6	190.6	530.2
Cooking	2.5	3.5	113.1	109.3	228.4
Lighting	–	–	–	95.3	95.3
Appliances	–	–	1.5	447.3	448.8
	130.4	377.5	945.4	1082.7	2536.0

* Of the 68.8 PJ of electricity used for space heating, an estimated 26.4 PJ was unrestricted supply, with 42.4 PJ off-peak.

** Of the 54.6 PJ of electricity used for water heating, an estimated 49.4 PJ was unrestricted supply, with 5.2 PJ off-peak.

Figure 3. Total energy use in the domestic sector split by end-use, 1980



Delivered Energy

Primary Fuel Equivalent

20. Gases comprised 53% of total energy consumption by the domestic sector in 1980. An informed estimate shows that some 64% of gas supplied to the sector was for space heating purposes, either through direct-acting appliances or in 'wet' central heating (CH) installations. The same estimate also shows that the ratio of energy use for space and water heating purposes in these CH installations is in the region of 65:35 in the favour of space heating.

21. The estimates of end-use consumption of solid fuels is based on information supplied by the Solid Fuels Advisory Service on the numbers of households using solid fuels for space heating and/or water heating and/or cooking purposes.

22. Electricity consumption data are taken from the Electricity Council's Domestic Sector Analysis for 1980/81. As the Analysis only covers the domestic use of electricity in England and Wales, it is assumed that the pattern of use is identical in Scotland and N Ireland and the figures are grossed up pro rata to agree with the aggregate data in the Digest of UK Energy Statistics.

23. Only electricity is used for all the five purposes mentioned in paragraph 19 above. Appliances used 41% of total electricity consumed in the sector with cookers using an extra 10%. Electricity use by individual appliances is outlined in Table 8.

Table 8. Electricity consumption by electrical appliances, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Washing machines	12.2	42.6
Heated clothes driers	2.7	9.4
Dishwashers	1.4	4.9
Refrigerators	17.1	59.7
Fridge/freezers	9.6	33.5
Freezers	23.0	80.3
Kettles	15.3	53.4
Irons	5.8	20.2
Vacuum cleaners	1.8	6.3
Television sets	25.7	89.8
Blankets	2.0	7.0
Sundries (radios etc)	11.5	40.2
	128.1	447.3

24. Electricity for space and water heating purposes does not follow the same pattern as that for other fuels since electricity displaces other fuels for direct water heating during the summer months when space heating is not usually required and this brings the annual aggregate electricity consumption totals for space and water heating into rough equivalence.

25. The consumption of liquid fuels (including butane/propane and burning oils) is based on the total oils estimated as being delivered to private houses and other dwellings as recorded in the Digest of UK Energy Statistics 1982.

2.2 Domestic Sector

26. Tables 9 and 10 disaggregate the estimated total energy used for space and water heating purposes respectively.

Table 9. Energy used in the domestic sector for space heating purposes, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
(a) Direct-Acting		
Butane/propane	10.2	11.2
Burning oil	15.0	16.5
Solid fuels	224.4	242.3
Natural gas/town gas	231.5	245.7
Electricity	23.6	82.4
(b) Via CH Installations (inc boilers)		
Gas/diesel oil & fuel oil	18.3	20.1
Burning oil	41.0	45.1
Solid fuels	49.7	53.7
Natural gas/town gas	337.5	358.5
Electricity	45.2	157.8
	996.4	1233.3

Table 10. Energy used in the domestic sector for water heating purposes, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
(a) Direct-Acting		
Solid fuels	45.5	49.2
Natural gas/town gas	35.6	37.8
Electricity	54.6	190.6
(b) Via CH Installations (inc boilers)		
Gas/diesel oil & fuel oil	9.8	10.8
Burning oil	22.1	24.2
Solid fuels	26.7	28.8
Natural gas/town gas	177.8	188.8
	372.1	530.2

2.3 COMMERCIAL AND INSTITUTIONAL BUILDINGS

27. Commercial and institutional buildings comprise the single most difficult sector to analyse in terms of energy use due to the heterogeneous nature of the building stock. Nevertheless, this study has drawn on previous and current estimates of energy use to produce the results which follow. These sources include data supplied by the Electricity Council and the CEGB, British Gas, employment and floorspace data.

28. The sector as a whole forms the Public Administration and Miscellaneous sectors described in the Digest of UK Energy Statistics (excluding the non-refinery use of oils by the petroleum industry).

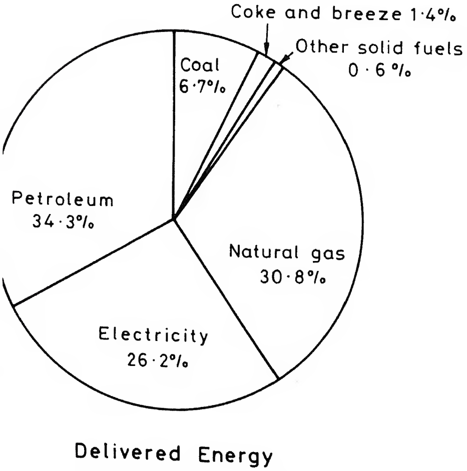
29. Some 705.8 PJ of fuel/energy carriers were consumed by the sector during 1980 in the UK - this is equivalent to about 12% of total UK energy consumption.

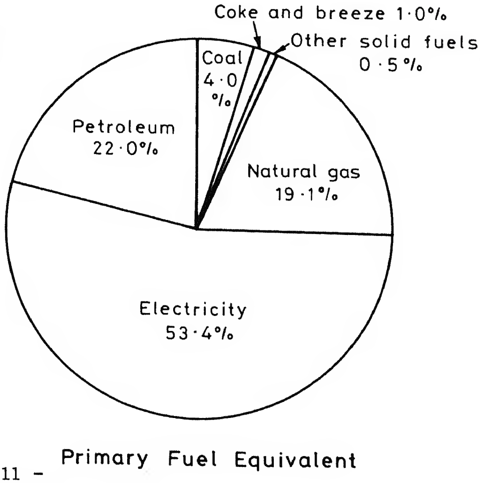
30. Table 11 and Figure 4 split total sectoral energy use by fuel/energy carrier.

Table 11. Energy supplied to commercial and institutional buildings by fuel, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Coal	47.5	48.9
Coke and Breeze	9.7	12.2
Other Solid Fuels	4.3	5.5
Natural Gas	216.6	229.4
Towns Gas	0.8	1.9
Electricity	184.8	645.2
Petroleum	242.1	265.9
	705.8	1209.0

Figure 4. Energy supplied to commercial and institutional buildings, by fuel, 1980





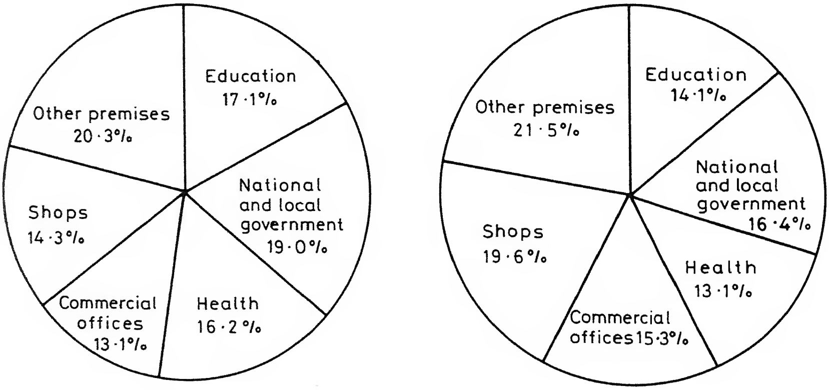
2.3 Commercial and Institutional Buildings

31. Table 12 and Figure 5 split total energy use by subsector. Estimates of the total energy supplied to individual subsectors are based on data contained in the Digest of UK Energy Statistics 1982, in the Annual Abstract of Statistics 1983, on Electricity Council/ CEGB data for the Commercial Sector and on other informed estimates.

Table 12. Energy supplied to commercial and institutional buildings, by subsector, 1980 (excluding public lighting), PJ

	Delivered Energy	Primary Fuel Equivalent
Education	119.6	166.8
National and Local Government (inc. Defence)	132.9	193.8
Health	113.1	155.1
Commercial Offices (inc. wholesale warehouses)	91.2	180.5
Shops (inc. public houses and clubs)	99.6	231.6
Other premises (inc. restaurants and hotels)	141.1	252.2
	697.5	1180.0

Figure 5. Energy supplied to commercial and institutional buildings, by subsector, 1980 (excluding public lighting)



Delivered Energy

Primary Fuel Equivalent

32. The building's physical characteristics, the numbers of people using it and the frequency of use ultimately determine the aggregate energy requirements of the building concerned. It is therefore highly unlikely that individual buildings within the same subsector will have identical patterns of energy use but certain types of building can be readily identified, however.

33. Besides the distinction between residential/two-shift and one-shift buildings, three main types can be identified:

(i) small and medium-sized commercial buildings. These are often old premises divided into smaller premises and rooms and do not generally have central heating;

(ii) larger commercial and public buildings in towns. These are generally centrally-heated using gas or gas oil;

(iii) semi-rural sites heated from central boiler houses fired by oil (usually heavy fuel oil).

34. The catering, hot water and appliance loads are directly related to the frequency of use of the building and the numbers of people using it, so that the energy demand estimates have taken account of both these factors. These building and building-use characteristics are reflected in the patterns of energy use detailed in Tables 14 to 18, e.g. the large lighting load of shops.

35. Table 13 shows that oil is the major fuel used in the sector as a whole (34% of total energy consumption) closely followed by gas (31%) and electricity (26%). The proportions of total energy consumption attributable to each fuel are however very different for the two main categories of buildings:

Table 13. Proportions of total energy use in commercial/institutional buildings split by fuel/energy carrier, 1980

Delivered Energy	Oil	Gas	Electricity	Solids
Public Admin./Institutional	45	27	15	13
Commercial	22	35	39	4
Proportion of total energy use	34	31	26	9

36. Tables 14 to 18 outline the pattern of energy use in commercial and institutional buildings both on an aggregate basis and by subsector. The large use of electricity by commercial sector buildings, notably shops (including public houses and clubs) where electricity accounts for some 51% of total energy use explains the commercial sector's high energy consumption in primary fuel equivalent terms (some 664.3 PJ).

37. Space and water heating accounted for 75% of the sector's total energy consumption (57% on a primary fuel basis) with lighting and cooking/catering accounting for 13% and 9% respectively, on a delivered energy basis. Details of energy end-use are presented both on a delivered energy and primary fuel basis in Tables 14 to 18.

2.3 Commercial and Institutional Buildings

Table 14. The pattern of energy use in commercial and institutional buildings, 1980, PJ

All buildings

	SOLIDS	LIQUIDS	GASES	ELECTRICITY	TOTAL
Delivered Energy					
Space heating	54.1	212.7	147.2	34.9*	448.9
Water heating	7.4	29.4	27.0	13.8*	77.6
Cooking/ Catering	-	-	43.2	18.3	61.5
Lighting	-	-	-	80.4	80.4
Public lighting	-	-	-	8.3	8.3
Air conditioning	-	-	-	14.2	14.2
Miscellaneous appliances	-	-	-	14.9	14.9
TOTAL	61.5	242.1	217.4	184.8	705.8
Primary Fuel Equivalent					
Space heating	58.7	231.9	157.0	121.8	569.4
Water heating	7.9	34.0	28.6	48.2	118.7
Cooking/ Catering	-	-	45.7	64.0	109.7
Lighting	-	-	-	280.7	280.7
Public lighting	-	-	-	29.0	29.0
Air conditioning	-	-	-	49.5	49.5
Miscellaneous appliances	-	-	-	52.0	52.0
TOTAL	66.6	265.9	231.3	645.2	1,209.0

* Of the 48.7 PJ of electricity attributed to space and water heating, an estimated 32.4 PJ unrestricted and 16.3 PJ off-peak electricity was consumed.

Table 15. The pattern of energy use in the commercial and institutional buildings sector, 1980, PJ

Public administration and institutional buildings

	SOLIDS	LIQUIDS	GASES	ELECTRICITY	TOTAL
Delivered Energy					
Space heating	42.9	149.0	60.9	8.7*	261.5
Water heating	5.7	19.7	11.6	2.2*	39.2
Cooking/ Catering	-	-	27.5	5.6	33.1
Lighting	-	-	-	26.2	26.2
Public lighting	-	-	-	8.3	8.3
Air conditioning	-	-	-	2.7	2.7
Miscellaneous appliances	-	-	-	2.9	2.9
TOTAL	48.6	168.7	100.0	56.6	373.9
Primary Fuel Equivalent					
Space heating	47.1	163.7	65.0	30.4	306.2
Water heating	6.2	23.6	12.3	7.7	49.8
Cooking/ Catering	-	-	29.1	19.6	48.7
Lighting	-	-	-	91.5	91.5
Public lighting	-	-	-	29.0	29.0
Air conditioning	-	-	-	9.4	9.4
Miscellaneous appliances	-	-	-	10.1	10.1
TOTAL	53.3	187.3	106.4	197.7	544.7

* 10.9 PJ of electricity for space and water heating made up of 8.7 PJ unrestricted and 2.2 PJ off-peak electricity.

2.3 Commercial and Institutional Buildings

Table 16. The pattern of energy use in the commercial and institutional buildings sector, 1980, PJ

Commercial sector buildings

	SOLIDS	LIQUIDS	GASES	ELECTRICITY	TOTAL
Delivered Energy					
Space heating	11.2	63.7	86.3	26.2*	187.4
Water heating	1.7	9.7	15.4	11.6*	38.4
Cooking/ Catering	–	–	15.7	12.7	28.4
Lighting	–	–	–	54.2	54.2
Air conditioning	–	–	–	11.5	11.5
Miscellaneous appliances	–	–	–	12.0	12.0
TOTAL	12.9	73.4	117.4	128.2	331.9
Primary Fuel Equivalent					
Space heating	11.6	68.2	92.0	91.4	263.2
Water heating	1.7	10.4	16.3	40.5	68.9
Cooking/ Catering	–	–	16.6	44.4	61.0
Lighting	–	–	–	189.2	189.2
Air conditioning	–	–	–	40.1	40.1
Miscellaneous appliances	–	–	–	41.9	41.9
TOTAL	13.3	78.6	124.9	447.5	664.3

* 37.8 PJ of electricity for space and water heating made up of 23.7 PJ unrestricted and 14.1 PJ off-peak electricity.

Table 17. Energy use in public administration/ institutional buildings by subsector, 1980

Delivered Energy, PJ

	SOLIDS	LIQUIDS	GASES	ELECTRICITY	TOTAL
(a) Education					
Space heating	14.6	38.2	19.3	2.8*	74.9
Water heating	2.6	6.6	6.3	0.7*	16.2
Cooking/ Catering	-	-	16.8	1.7	18.5
Lighting	-	-	-	8.6	8.6
Air conditioning	-	-	-	0.8	0.8
Miscellaneous appliances	-	-	-	0.6	0.6
TOTAL	17.2	44.8	42.4	15.2	119.6
TOTAL (Primary Fuel Equiv.)	18.8	49.8	45.1	53.1	166.8
(b) National & Local Gov. (incl. Defence)					
Space heating	9.3	70.6	23.7	3.3*	106.9
Water heating	0.5	3.8	1.5	0.8*	6.6
Cooking/ Catering	-	-	3.5	2.9	6.4
Lighting	-	-	-	10.0	10.0
Air conditioning	-	-	-	1.2	1.2
Miscellaneous appliances	-	-	-	1.8	1.8
TOTAL	9.8	74.4	28.7	20.0	132.9
TOTAL (Primary Fuel Equiv.)	10.8	82.6	30.5	69.9	193.8
(c) Health					
Space heating	19.0	40.2	17.9	2.6*	79.7
Water heating	2.6	9.3	3.8	0.7*	16.4
Cooking/ Catering	-	-	7.2	1.0	8.2
Lighting	-	-	-	7.6	7.6
Air conditioning	-	-	-	0.7	0.7
Miscellaneous appliances	-	-	-	0.5	0.5
TOTAL	21.6	49.5	28.9	13.1	113.1
TOTAL (Primary Fuel Equiv.)	23.7	54.9	30.8	45.7	155.1

* Electricity for space and water heating made up as follows:
Education: 2.7 PJ unrestricted and 0.8 PJ off peak;
National and Local Government: 3.3 PJ unrestricted and 0.8 PJ off-peak;
Health: 2.7 PJ unrestricted and 0.6 PJ off-peak.

** Public lighting is excluded, see Table 15.

2.3 Commercial and Institutional Buildings

Table 18. Energy use in commercial buildings by subsector, 1980

Delivered Energy, PJ

	SOLIDS	LIQUIDS	GASES	ELECTRICITY	TOTAL
(a) Commercial Offices (inc. wholesale warehouses)					
Space heating	3.9	20.6	30.7	9.8*	65.0
Water heating	–	0.2	0.2	2.5*	2.9
Cooking/ Catering	–	–	1.1	1.3	2.4
Lighting	–	–	–	13.9	13.9
Air conditioning	–	–	–	2.9	2.9
Miscellaneous appliances	–	–	–	4.1	4.1
TOTAL	3.9	20.8	32.0	34.5	91.2
TOTAL (Primary Fuel Equiv.)	4.0	22.2	33.9	120.4	180.5
(b) Shops (inc. public houses and clubs)					
Space heating	2.8	20.1	15.7	8.5*	47.1
Water heating	0.6	4.2	2.3	5.6*	12.7
Cooking/ Catering	–	–	1.2	7.0	8.2
Lighting	–	–	–	24.0	24.0
Air conditioning	–	–	–	3.0	3.0
Miscellaneous appliances	–	–	–	4.6	4.6
TOTAL	3.4	24.3	19.2	52.7	99.6
TOTAL (Primary Fuel Equiv.)	3.5	23.8	20.3	184.0	231.6
(c) Other Premises (inc. restaurants & hotels)					
Space heating	4.5	23.0	39.9	7.9*	75.3
Water heating	1.1	5.3	12.9	3.5*	22.8
Cooking/ Catering	–	–	13.4	4.4	17.8
Lighting	–	–	–	16.3	16.3
Air conditioning	–	–	–	5.6	5.6
Miscellaneous appliances	–	–	–	3.3	3.3
TOTAL	5.6	28.3	66.2	41.0	141.1
TOTAL (Primary Fuel Equiv.)	5.8	32.6	70.7	143.1	252.2

* Electricity for space and water heating made up as follows:
Commercial Offices: 6.5 PJ unrestricted and 5.8 PJ off-peak;
Shops: 9.4 PJ unrestricted and 4.7 PJ off-peak;
Other Premises: 7.8 PJ unrestricted and 3.6 PJ off-peak.

2.4 AGRICULTURE

38. Agriculture is a relatively minor user of energy, consuming some 62.7 PJ in 1980 (equivalent to 1% of UK energy consumption).

39. Liquid fuels provided 75% of the sector's energy requirements and these were split between driers and heaters relative to power units in the ratio 40:60. A small amount of electricity was used for heating and drying (0.3 PJ) with the rest providing stationary motive power of one form or another.

40. The pattern of energy use described in Table 19 and Figure 6 is based on data in the Digest of UK Energy Statistics 1982 and on ETSU Report R7.

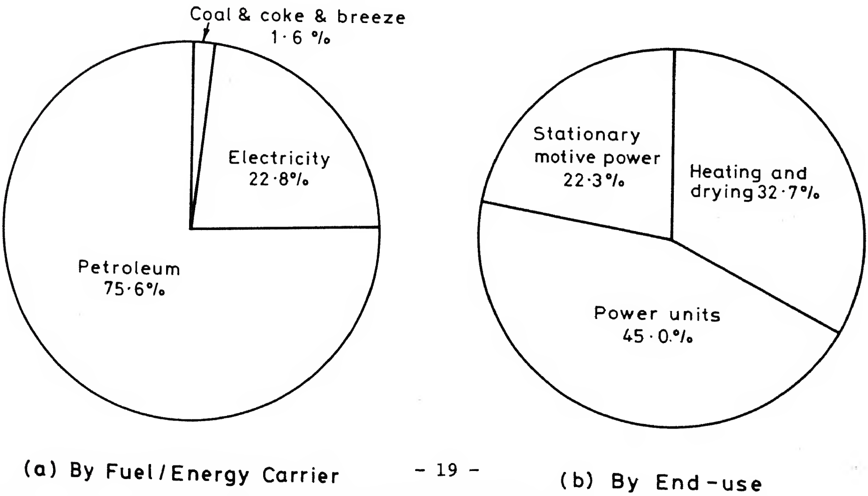
Table 19. The pattern of energy use in agriculture, 1980
Delivered Energy - PJ

	Solids	Liquids	Electricity	Total
Heating and Drying	1.0	19.2	0.3	20.5
Power Units*	-	28.2	-	28.2
Stationary Motive Power (electrical machinery)	-	-	14.0	14.0
TOTAL	1.0	47.4	14.3	62.7
TOTAL (Primary Fuel Equiv.)	1.1	52.1	49.9	103.1

* General farm machinery, including tractors.

Figure 6. Energy use in agriculture, 1980

Delivered Energy



(a) By Fuel/Energy Carrier

(b) By End-use

2.5 THE IRON AND STEEL INDUSTRY

41. The iron and steel industry accounted for 5% of UK energy consumption and 15% of total industrial energy use in 1980. 1980 was an anomalous year because of the effects of an industrial dispute; the equivalent proportions for 1981 were 6% and 18% respectively. The pattern of energy use in the industry in 1981 is therefore also presented in this section.

42. The industry is normally analysed separately from the rest of industry for a number of reasons. Not only is it such a large user of energy but it also provides many of its own energy requirements internally. Coke and breeze, gases and electricity are all produced in substantial amounts within the industry. The fact that 1980 was an anomalous year is also another reason for analysing the industry separately.

43. According to the Digest of UK Energy Statistics, the industry consumed some 302.4 PJ of fuels/energy carriers in 1980 with 342.8 PJ used in 1981. Table 20 provides a breakdown of the fuels/energy carriers used. Figure 7 provides the same breakdown for 1980 and 1981.

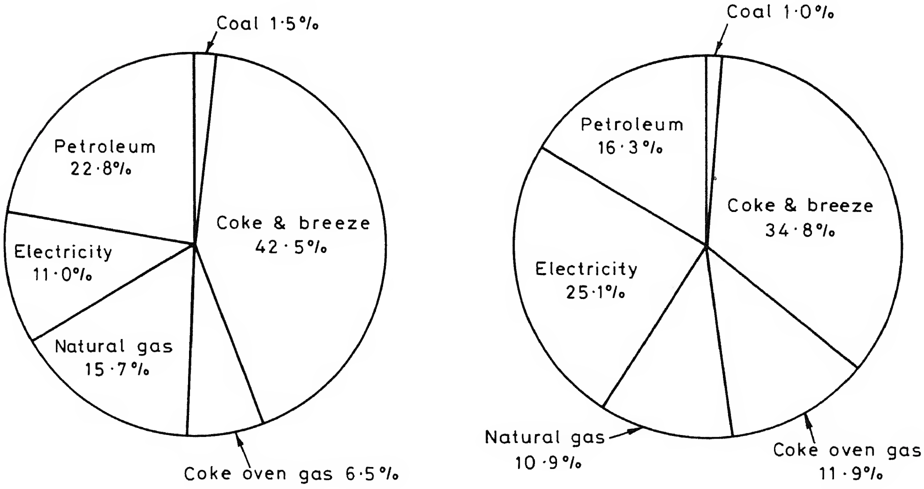
Table 20 (a). Energy use in the iron and steel industry, split by fuel/energy carrier, 1980, PJ

	Delivered Energy	Primary Fuel Equivalent
Coal	4.6	4.7
Coke and breeze	127.8	161.0
Coke oven gas	19.6	55.4
Natural gas	47.6	50.4
Electricity	33.3	116.3
Petroleum	68.9	75.7
Creosote/pitch	0.6	0.7
	302.4	464.2

(b) Energy use in the iron and steel industry, split by fuel/energy carrier, 1981, PJ

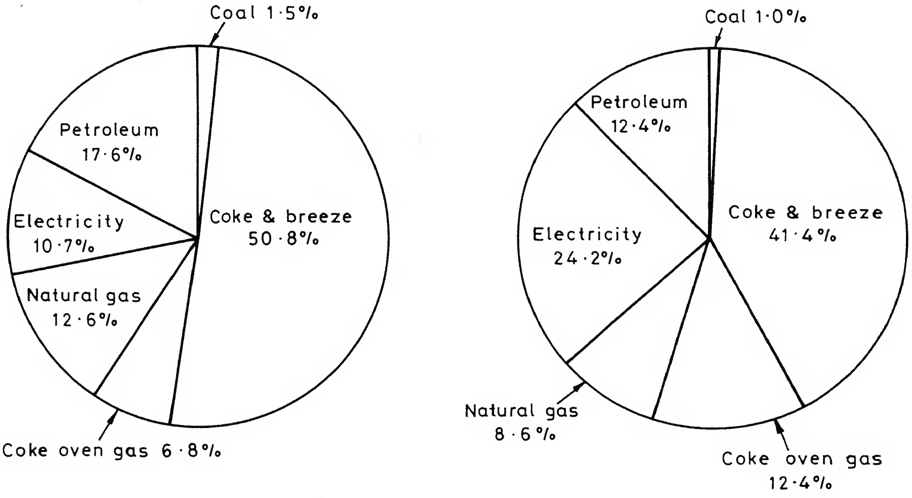
	Delivered Energy	Primary Fuel Equivalent
Coal	5.3	5.5
Coke and breeze	174.1	219.4
Coke oven gas	23.3	65.9
Natural gas	43.2	45.7
Electricity	36.8	128.5
Petroleum	59.9	65.8
Creosote/pitch	0.2	0.2
	342.8	531.0

Figure 7 (a). Energy use in the iron and steel industry, split by fuel/ energy carrier, 1980



Delivered Energy **Primary Fuel Equivalent**

(b) Energy use in the iron and steel industry, split by fuel/ energy carrier, 1981



Delivered Energy **Primary Fuel Equivalent**

44. It must be remembered, however, that the Digest does not include the coke-producing activity of the industry as part of the industry's operations for the purpose of calculating aggregate energy requirements. Rather, it treats coke ovens, as in the Annex to this Report, as a secondary fuel producing subsector.

45. In this analysis, however, coke ovens are analysed and treated as part of the industry, so that the gross energy requirements of the industry are substantially larger than those reported in the Digest, see Tables 21 and 22. However, after allowance for coke oven operations and coke and breeze stock changes, the net energy supply matches that reported.

46. Thus, all energy inputs, from those in the initial processing of the industry's basic materials to those used in the refining of finished products are included in Tables 21 and 22. Information gathered by ETSU, in addition to the published data in the Digest of UK Energy Statistics, the Energy Audit of the industry and the Iron and Steel Statistics Bureau Reports were all used in the preparation of Tables 21 and 22. Final use energy data are categorised under six general headings and, where possible, these categories are split into identifiable processes or end-uses of energy.

47. Due to the complex interactions between processes and intraplant usage of byproduct fuels, eg blast furnace gas, a clearly defined analysis of all energy end-uses is difficult to achieve. An integrated steelworks is a multi-process plant where outputs and stocks of fuel held at one plant greatly depend on the operations of others. Coke ovens and blast furnaces operate most efficiently when working at a steady rate, so that stocks of coke and iron both vary according to the rates of turnover of the casting and finishing plants further downstream.

48. Thus, when disruptions in the production processes do occur, as in 1980, losses and 'unaccounted for' uses of fuels are more likely to occur. A glance at the comparable estimates for certain end-uses in 1980 and 1981 would make this evident, e.g. the larger use of conventional fuels, i.e. oil and natural gas, to fire boilers in 1980, due to the shortfall in the production of coke oven and blast furnace gases. It is, moreover, difficult to monitor and hence obtain good data on the minor uses of energy, e.g. lighting.

49. The main fuel inputs and end-uses in the industry can be identified using the sources quoted in paragraph 46. Coal constitutes the largest single fuel used (if one includes the coke ovens as part of the industry's operations) amounting to 220.4 PJ in 1980 and 237.3 PJ in 1981. Some 98% of this coal input is consumed in the coke ovens, which produced 144.1 PJ and 152.9 PJ of coke and breeze in 1980 and 1981 respectively. Small amounts of coal are also used to fire boilers and in the production of iron castings. Iron foundries are treated as part of the iron and steel industry in this analysis.

50. Most of the coke and breeze produced is used in the iron-making processes - some 81% of coke and breeze produced (117.0 PJ) was used in the blast furnaces and sinter and pellet plant in 1980. As can be seen from Table 21, however, 1980 was anomalous in that unusually large additions to stocks of coke and breeze were made. These stocks were drawn on in 1981 to meet the increased energy demands, as production of iron and steel recovered.

51. A valuable byproduct of the coke making process is coke oven gas. This is used extensively for heating purposes further downstream in the production process either by itself or as part of a mixture with blast furnace gas. The two gases also provide a substantial part of the boiler-firing fuels needed, although, for reasons already stated, these were not as important in 1980 in this respect as normal.

52. Liquid fuels were the second largest fuel input to the industry in 1980 (68.9 PJ) and were made up of 80% fuel oil, 17% gas/diesel oil and a small amount of LPG. Most oil was used to fire boilers and in the metal-finishing processes, e.g. reheating furnaces, soaking pits. Billets and slabs are the main outputs of the primary finishing processes and are transformed into a final form as plate, sheet or bar in the secondary finishing plants. Post-finishing operations, involving further metal-shaping and cold-rolling also used substantial amounts of energy, notably electricity. Natural gas followed a similar pattern of use as liquid fuels with relatively more being used in 1981 than in 1980.

53. Electricity was used primarily for motive power, most notably in the post-finishing operations already mentioned. Substantial amounts of electricity are also used in the electric arc furnaces for melting down the steel scrap which is the main input to these furnaces. It is estimated that private generation in the industry provided 3.1 PJ and 3.7 PJ of electricity requirements in 1980 and 1981 respectively. The electricity used in the production of oxygen for use in basic oxygen converters is accredited as an energy input to the industry although it is manufactured elsewhere.

54. Tables 21 and 22 provide a full breakdown of the estimates of energy used by the industry in 1980 and 1981: figures in brackets denote negative amounts in the supply and demand balances outlined.

2.5 The Iron and Steel Industry

Table 21. The Pattern of Energy Use in the Iron and Steel Industry, 1980

	PJ - DELIVERED ENERGY							
	SOLIDS		LIQUIDS	GASES		ELECTRICITY	STEAM	TOTAL
	Coal	Coke & Breeze		Natural	Other			
Gross Energy Supplied	220.4	8.6	68.9	47.6	-	37.1	-	382.6
Coke Oven Operations	(215.8)	144.7	(3.0)	(2.6)	17.7*	(0.4)	(3.6)	(63.0)
Stock Increases	-	(21.7)	-	-	-	-	-	(21.7)
Net Energy Supplied	4.6	131.6	65.9	45.0	17.7	36.7	(3.6)	297.9
Private Generation/CHP	(2.3)	-	(12.1)	(3.0)	(16.7)	3.1	19.4	(11.6)
Sales to Public Supply/Others	-	-	-	-	(0.3)	(1.2)	-	(1.5)
Losses in Distribution	(0.2)	(3.2)	(2.4)	(2.3)	(7.2)	-	(4.5)	(19.8)
Energy to Final Uses	2.1	128.4	51.4	39.7	(6.5)	38.6	11.3	265.0
Final Uses								
(a) Iron Making								
Production of Sinter and Pellets (D)	-	12.8	3.7	0.7	-	0.6	-	17.8
Blast Furnaces (D)	-	104.8	3.5	-	(25.1)**	0.5	-	83.7
Blast Furnaces (C. S/W)	1.0	-	8.1	7.4	0.8	-	7.1	24.4
(b) Steel Making								
Oxygen Production (D)	-	-	-	-	-	2.2	-	2.2
Basic Oxygen (D)	-	-	-	-	-	0.4	-	0.4
Electric Arc (D)	-	1.6	-	-	-	9.4	-	11.0
(c) Metal Finishing								
Primary: Ingot Casting (D)	-	-	6.3	3.5	-	2.6	-	12.4
Primary: Ingot Casting (C. S/W)	-	-	0.4	0.4	-	-	0.5	1.3
Primary: Continuous Casting (D)	-	-	0.5	0.2	-	0.2	-	0.9
Secondary (D)	-	-	12.0	9.0	17.7	2.9	-	41.6
(d) Post-Finishing Operations (D)	-	-	10.4	13.0	-	13.0	-	36.4
(e) Production of Iron Castings (D)	0.4	9.2	2.7	-	-	3.7	-	16.0
(f) Non-Process Energy Uses								
Space and Water Heating (D)	-	-	-	0.7	-	0.1	3.7	4.5
Space and Water Heating (C. S/W)	0.7	-	3.8	2.9	0.1	-	-	7.5
Lighting/Appliances	-	-	-	1.9	-	3.0	-	4.9
	2.1	128.4	51.4	39.7	(6.5)	38.6	11.3	265.0

D: as direct energy input.
C. S/W: as steam via central steam/water system.
* Net output of coke oven gas.
** Net output of blast furnace gas.
*** Figures in brackets denote negative amounts in the energy balance.

Table 22. The Pattern of Energy Use in the Iron and Steel Industry, 1981

	PJ - DELIVERED ENERGY							
	SOLIDS		LIQUIDS	GASES		ELECTRICITY	STEAM	TOTAL
	Coal	Coke & Breeze		Natural	Other			
Gross Energy Supplied	237.3	5.8	59.9	43.2	-	42.4	-	388.6
Coke Oven Operations	(232.0)	153.1	(1.2)	(0.9)	20.6*	(0.4)	(4.2)	(65.0)
Stock Decreases	-	18.2	-	-	-	-	-	18.2
Net Energy Supplied	5.3	177.1	58.7	42.3	20.6	42.0	(4.2)	341.8
Private Generation/ CHP	(2.7)	-	(14.4)	(3.5)	(20.1)	3.7	23.2	(13.8)
Sales to Public Supply/ Others	-	-	-	-	(0.4)	(1.2)	-	(1.6)
Losses in Distribution	(0.3)	(2.8)	(0.8)	(0.6)	(6.1)	-	(4.6)	(15.2)
Energy to Final Uses	2.3	174.3	43.5	38.2	(6.0)	44.5	14.4	311.2
Final Uses								
(a) Iron Making								
Production of Sinter and Pellets (D)	-	14.3	3.3	1.2	-	0.9	-	19.7
Blast Furnaces (D)	-	152.2	-	-	(33.4)**	0.8	-	119.6
Blast Furnaces (C. S/W)	1.2	-	1.7	1.3	3.3	-	10.1	17.6
(b) Steel Making								
Oxygen Production (D)	-	-	-	-	-	4.0	-	4.0
Basic Oxygen (D)	-	-	-	-	-	0.6	-	0.6
Electric Arc (D)	-	1.8	-	-	-	10.3	-	12.1
(c) Metal Finishing								
Primary: Ingot Casting (D)	-	-	5.8	4.4	-	2.9	-	13.1
Primary: Ingot Casting (C. S/W)	-	-	0.2	0.1	0.3	-	0.5	1.1
Primary: Continuous Casting (D)	-	-	0.4	0.2	-	0.3	-	0.9
Secondary (D)	-	-	17.8	8.0	22.2	4.2	-	52.2
(d) Post-Finishing Operations (D)	-	-	8.7	17.9	-	14.8	-	41.4
(e) Production of Iron Castings (D)	0.4	6.0	2.2	-	-	2.8	-	11.4
(f) Non-Process Energy Uses								
Space and Water Heating (D)	-	-	-	0.7	-	0.1	3.8	4.6
Space and Water Heating (C. S/W)	0.7	-	3.4	2.7	1.6	-	-	8.4
Lighting/ Appliances	-	-	-	1.7	-	2.8	-	4.5
	2.3	174.3	43.5	38.2	(6.0)	44.5	14.4	311.2

D: as direct energy input.
C. S/W: as steam via central steam/water system.
* Net output of coke oven gas.
** Net output of blast furnace gas.
*** Figures in brackets denote negative amounts in the energy balance.

2.6 OTHER INDUSTRY

2.6.1 Summary

55. The other industry section is comprised of the industrial sectors, other than the iron and steel industry, described in the Digest of United Kingdom Energy Statistics. These industrial sectors are:

(1) Food, drink and tobacco

(2) Engineering and other metal trades

(3) Textiles, leather and clothing

(4) Paper, printing and stationery

(5) Bricks, tiles, fireclay and other building materials

(6) China, earthenware and glass

(7) Cement

(8) Chemicals and allied trades

(9) Other trades.

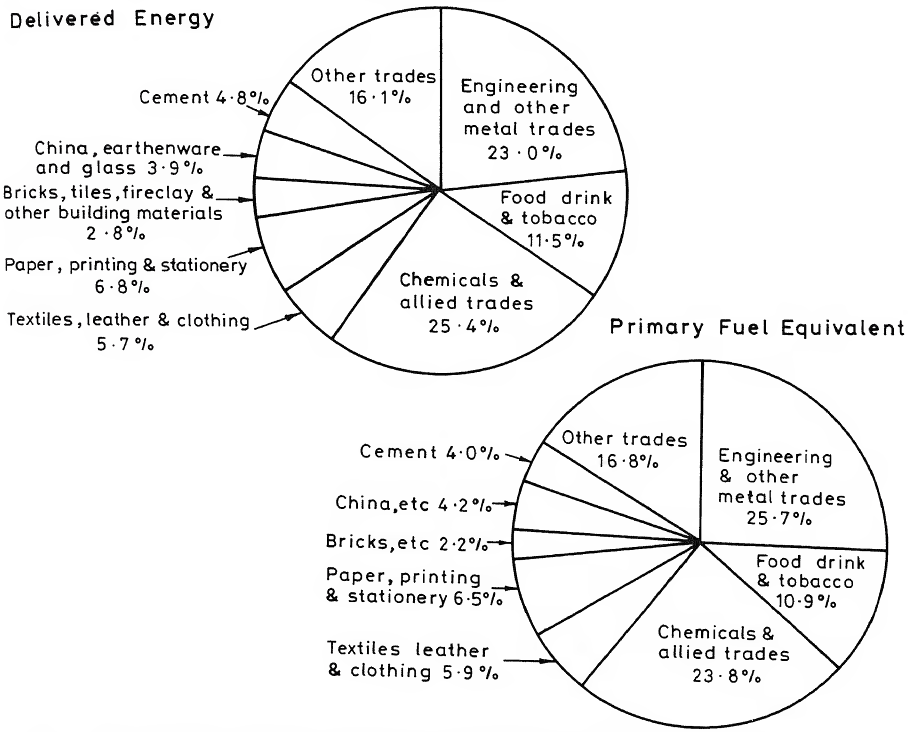
56. Other industry consumed a total of 1,717.9 PJ of conventional, recorded fuels/energy carriers during 1980. This was equivalent to 28.8% of aggregated UK consumption, making it the largest single user of energy in that year. Tables 23 and 24 and Figures 8 and 9 show aggregate energy consumption for 1980 split by industrial sector and by fuel/energy carrier. Details of such splits for industrial subsectors are contained in sections 2.6.2 to 2.6.10.

Table 23. Energy use in other industry split by sector, 1980

	PJ Delivered Energy	Primary Fuel Equivalent
Food, drink and tobacco	197.8	270.6
Engineering and other metal trades	394.6	635.3
Textiles, leather and clothing	98.4	146.5
Paper, printing and stationery	116.5	161.7
Bricks, tiles, fireclay and other building materials	48.0	55.1
China, earthenware and glass	66.8	103.2
Cement	83.0	100.0
Chemicals and allied trades*	435.8	588.0
Other trades	277.0	411.4
	1717.9	2471.8

* includes natural gas feedstocks

Figure 8. Energy use in other industry split by sector, 1980



57. The relative amounts of fuels and energy-carriers used vary widely across sectors, these being determined by technological, economic and other considerations. The pattern of energy use also varies widely from sector to sector and between industrial subsectors although similar general energy use characteristics can often be noticed among subsectors, e.g. manufacturing processes in the food, drink and tobacco sector do not usually take place at a temperature exceeding 250° C.

58. Because the section is so diverse, it necessarily means that there exists a potentially enormous number of individual end-use categories - even a study of the use of a technology such as firing via kilns or furnaces could result in an extremely large matrix of data if end-use splits into type, capacity and process temperature were to be made.

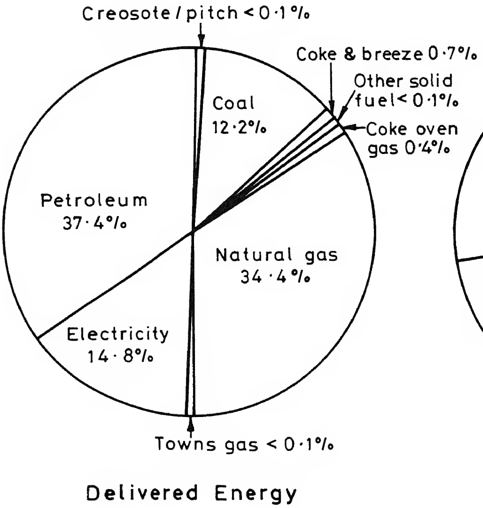
59. For the purposes of the major part of this study, such detailed splits have not been made although estimates of the amounts of energy used by distinguishable technologies have been made where possible and are presented accordingly. The more general end-use categories employed are discussed in paragraph 60.

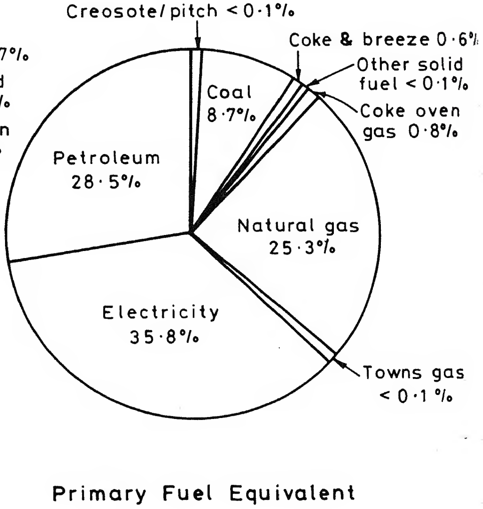
2.6.1 Other Industry

Table 24. Energy use in other industry split by fuel/energy carrier, 1980

	PJ Delivered Energy	Primary Fuel Equivalent
Coal	208.3	214.4
Coke and breeze	11.9	15.0
Other solid fuel	1.3	1.6
Coke oven gas	7.3	20.7
Natural gas	591.5	626.2
Towns gas	0.5	1.2
Electricity	253.8	886.1
Petroleum	642.4	705.6
Creosote/pitch	0.9	1.0
	1717.9	2471.8

Figure 9. Energy use in other industry split by fuel/energy carrier, 1980





60. Details of the end-use categories common to all sectors of other industry are presented so that comparisons can be made. These categories are as follows:

(a) Process energy

- (i) by central steam/water systems split by temperature at end-use;
- (ii) by direct process plant split by temperature at end-use;
- (iii) energy for stationary motive power, i.e. electrical energy for process plant such as compressors, shafts, conveyors, etc; and
- (iv) electrochemical energy.

(b) Space and water heating

- (i) by central steam/water systems;
- (ii) by local boiler plant, and
- (iii) by direct-acting plant.

(c) Lighting/appliances This category includes energy used for catering purposes and miscellaneous uses.

(d) Off-road vehicles Using data supplied by the Department of Transport and the Electric Vehicle Association of Great Britain, it is estimated that off-road vehicles consumed a total of 34.5 PJ in 1980. This total is subdivided as follows:

Energy consumed by off-road vehicles, 1980

	PJ, Delivered Energy
Liquid Fuels*	
Construction industry	26.7
Other industry	4.6
Electricity	
All off-road works trucks	3.4
	34.7

* It is estimated that the 31.3 PJ of liquid fuels consumed is made up as follows: 0.8 PJ motor spirit, 30.5 PJ diesel fuel. In addition, it is estimated that some 33,000 electrical on-road vehicles consumed an estimated 1.0 PJ during 1980. Electricity for road vehicles is not included in the data supplied in the Digest of UK Energy Statistics, but is incorporated in the sectoral analyses presented here.

61. The large volume of information collected by ETSU on industrial energy use has formed the basis for the sectoral patterns of energy uses described in

2.6.1 Other Industry

This information has been collected through the use of official statistics and communication with individuals, companies, research associations, energy supply industries and Government Departments.

62. Sections 2.6.2 to 2.6.10 use the Digest of UK Energy Statistics for sectoral totals and splits by fuel carrier. The end use analysis has been obtained from the above sources.

63. Tables 25 and 26 present a complete summary of the analysis of energy used by industry (excluding iron and steel) in 1980. Table 25 describes the main features of energy use, including the volumes of fuels passed through boilers and the amounts of energy supplied directly to process plant. The relative proportions vary widely across industrial sectors. Table 26 presents an aggregated picture of energy use in industry.

Table 25. Summary of Energy Use in Other Industry, 1980

PJ - Delivered Energy	Food, Drink & Tobacco		Engineering & Other Metal Trades		Textiles, Leather & Clothing		Paper, Printing & Stationery		Bricks, Tiles, Fireclay & Other Bldg Materials		China, Earthenware & Glass		Cement		Chemicals & Allied		Other Trades	
	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%
Gross Energy Supplied*	197.8	100	394.6	100	98.4	100	116.5	100	48.0	100	66.8	100	83.0	100	435.8	100	277.0	100
Energy through all boilers:																		
(a) for process use	95.1	48.1	19.0	4.8	37.2	37.8	22.5	19.3	3.6	7.5	1.0	1.5	–	–	42.6	9.8	70.0	25.3
(b) for space/water heating	23.8	12.0	153.2	38.8	26.9	27.3	10.7	9.2	5.3	11.0	3.9	5.8	0.3	0.4	9.6	2.2	53.3	19.2
(c) for private generation/CHP	30.0	15.2	31.1	7.9	10.4	10.6	58.0	49.8	–	–	–	–	–	–	162.0	37.2	12.0	4.3
(d) lost in distribution	6.0	3.0	8.9	2.2	3.0	3.0	1.7	1.5	0.5	1.0	0.1	0.1	–	–	5.7	1.3	5.4	1.9
TOTAL	154.9	78.3	212.2	53.7	77.5	78.7	92.9	79.8	9.4	19.5	5.0	7.4	0.3	0.4	219.9	50.5	140.7	50.7
Energy supplied direct to process plant	22.4	11.3	101.4	25.7	3.2	3.3	0.7	0.6	32.8	68.3	51.6	77.2	76.0	91.6	67.6	15.5	35.6	12.9
Energy for motive power	14.1	7.1	48.4	12.3	13.5	13.7	12.5	10.7	1.8	3.7	8.2	12.3	4.4	5.3	29.7	6.8	75.5	27.3
Other uses (lighting etc)	6.4	3.3	32.6	8.3	4.2	4.3	10.4	8.9	4.0	8.5	2.0	3.1	2.3	2.7	118.6	27.2	25.2	9.1
TOTAL	197.8	100	394.6	100	98.4	100	116.5	100	48.0	100	66.8	100	83.0	100	435.8	100	277.0	100
Total process energy	143.8	72.7	128.9	32.7	48.3	49.1	67.3	57.8	36.4	75.8	52.6	78.7	76.0	91.6	251.5	57.7	110.0	39.7
Total space/water heating	28.4	14.4	192.8	48.9	30.2	30.7	29.9	25.6	8.7	18.1	4.9	7.3	2.1	2.5	23.1	5.3	79.8	28.8
Total others (inc losses)	25.6	12.9	72.9	18.4	19.9	20.2	19.3	16.6	2.9	6.1	9.3	14.0	4.9	5.9	161.2	37.0	87.2	31.5
TOTAL	197.8	100	394.6	100	98.4	100	116.5	100	48.0	100	66.8	100	83.0	100	435.8	100	277.0	100

* As given in the Digest of UK Energy Statistics, i.e. conventional fuels only and excluding electricity for off-road vehicles.

2.6.1 Other Industry

Table 26. The Pattern of Energy Use in Other Industry, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross Energy Supplied	642.4	222.4	599.3	253.8	-	1717.9
Feedstocks	-	-	(113.2)	-	-	(113.2)
Private Generation/ CHP	(137.6)	(63.7)	(102.2)	39.9	180.7	(82.9)
Sales to Public Supply/ others	-	-	-	(4.3)	-	(4.3)
Losses in Distribution	(15.7)	(2.9)	(12.7)	-	(9.3)	(40.6)
Net Energy Supplied	489.1	155.8	371.2	289.4	171.4	1476.9
(a) Process Energy						
Via central steam/ water systems:						
< 80° C	25.2	6.2	15.9	-	20.1	67.4
80-120° C	72.4	15.1	44.9	-	68.5	200.9
> 120° C	62.5	9.6	39.2	-	59.2	170.5
Via direct-process plant:						
< 200° C	17.8	4.2	21.4	9.2	-	52.6
200-400° C	17.2	1.0	38.0	2.0	-	58.2
> 400° C	64.3	89.6	76.9	19.5	-	250.3
Electrochemical	-	-	-	40.3	-	40.3
Stationary motive power	18.2	-	1.0	178.9	-	198.1
(b) Space and Water Heating						
Via central steam/ water systems	123.8	25.0	93.0	-	-	241.8
Via local boiler plant	29.9	5.1	10.2	-	-	45.2
Via direct-acting plant	26.5	-	20.1	13.6	23.6	83.8
(c) Lighting/ Appliances	-	-	10.6	25.9	-	36.5
(d) Off-road Vehicles	31.3	-	-	-	-	31.3
	489.1	155.8	371.2	289.4	171.4	1476.9
Primary Fuel Equivalent of Gross Energy Supplied	705.6	232.0	648.1	886.1	-	2471.8

Notes:
(1) Non-conventional energy sources are not included
(2) Petroleum feedstocks for use in the petrochemical industry are not included
(3) Electricity consumed by off-road works vehicles is not included
(4) Digest of UK Energy Statistics data on total energy use is used

2.6.2 The Food, Drink and Tobacco Sector

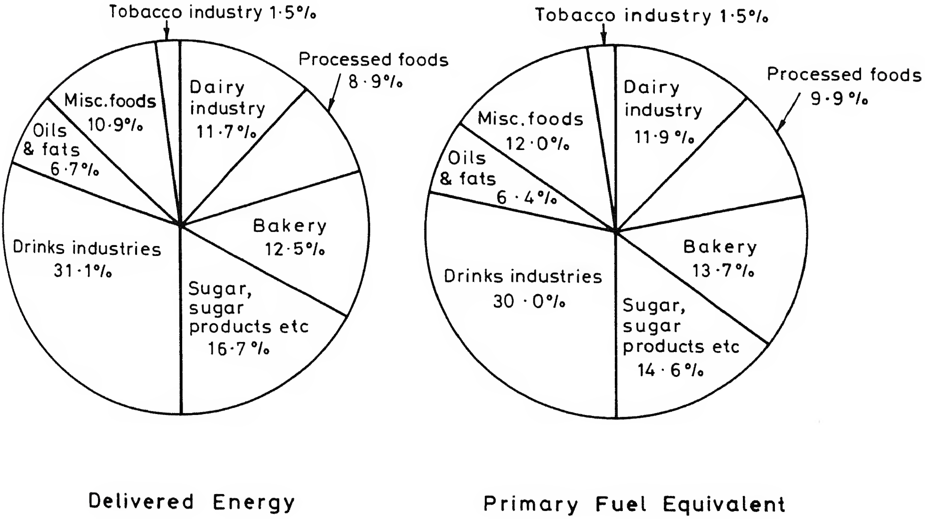
64. The food, drink and tobacco sector consumed 197.8 PJ of conventional, recorded fuels/energy carriers in 1980, this being equivalent to 11.5% of total consumption by the other industry section.

65. Tables 27 and 28 and Figures 10 and 11 show total energy use split both by subsector and by fuel/energy-carrier.

Table 27. Energy use in food, drink and tobacco split by subsector, 1980

	PJ Delivered Energy	Primary Fuel Equivalent
Dairy Industry	23.2	32.1
Processed foods	17.7	26.8
Bakery products	24.7	37.0
Sugar and sugar products	33.1	39.5
Drinks industries	61.5	81.1
Oils and fats	13.3	17.3
Miscellaneous foods	21.6	32.5
Tobacco industry	2.7	4.3
	197.8	270.6

Figure 10. Energy use in food, drink and tobacco split by subsector, 1980

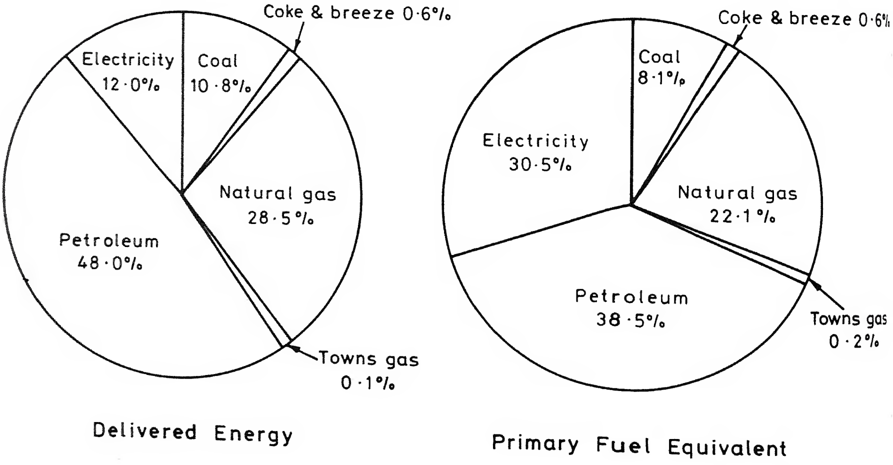


2.6.2 Food, Drink and Tobacco

Table 28. Energy use in food, drink and tobacco split by fuel/ energy carrier, 1980

	PJ Delivered Energy	Primary Fuel Equivalent
Coal	21.3	21.9
Coke and breeze	1.2	1.5
Natural gas	56.4	59.7
Towns gas	0.2	0.5
Petroleum	95.0	104.3
Electricity	23.7	82.7
	197.8	270.6

Figure 11. Energy use in food, drink and tobacco split by fuel/ energy carrier, 1980



66. Table 31 provides a breakdown of energy supply and uses for the whole sector. For technological reasons i.e. process temperatures rarely need to exceed 200°C so that most of the sectors' energy requirements are provided by central steam/ water systems.

67. Subsectoral splits of total fuels/energy carriers used are given in Tables 32 to 39. The volumes and proportions of fuels used vary greatly from sector to sector although liquids are in all instances the predominant fuel used, except in the case of the bread and flour confectionery, biscuits and grain milling subsector.

68. Energy through central steam/water systems (defined as fuels and steam indirectly used as process energy, for space/water heating purposes, for CHP schemes and distribution losses, as a proportion of gross energy supplied) amounted to some 78%. Equivalent totals for each subsector were as follows:

Table 29. Proportions of total energy used in central steam/water systems, 1980

Dairy industry	84%
Processed foods	75%
Bakery products	44%
Sugar and sugar products	92%
Drinks industries	79%
Oils and fats	85%
Miscellaneous foods	78%
Tobacco industry	59%

69. Steam/hot water is used for numerous processes: these include preparation (blanching, peeling, mixing and blending etc.); cooking; evaporation, concentration and drying; pasteurisation and sterilisation.

70. Only in biscuits manufacture, tobacco, malting and some elements of the fruit and vegetable/meat and fish industries is direct-process plant a relatively large user of supplied energy. Estimates of energy supplied to direct-process plant in 1980 are as follows:

Table 30. Energy used by direct-process plant in food, drink and tobacco industry, 1980

			PJ - Delivered Energy
(a)	Dryers		0.8
	- by fuel:	Gas	0.6
		Electricity	0.2
(b)	Kilns		4.6
	- by fuel:	Gas	2.5
		Oil	2.1
(c)	Ovens		9.6
	- by fuel:	Gas	7.6
		Oil	1.4
		Electricity	0.6
(d)	Refrigeration plant		7.5
	- by fuel:	Electricity	7.2
		Refrigerant	0.3
(e)	Stills		0.8
	- by fuel:	Gas	0.5
		Coal	0.1
		Oil	0.2

2.6.2 Food, Drink and Tobacco

71. About 2 PJ of electricity was generated within the sector during 1980, 75% of which was within the sugar, and sugar products subsector. Small amounts were generated in the brewing and malting industries and the oils/fats and miscellaneous foods subsectors. Fuels used for the production of privately generated electricity and steam are presented in brackets in Tables 31 to 39, the brackets denoting negative values in the overall energy balances.

Table 31: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

	PJ - Delivered Energy						
	Liquids	Solids	Gases	Electricity	Steam	Other*	Total
Gross Energy Supplied	95.0	22.5	56.6	25.0	1.4	0.3	200.8
Private Generation/CHP	(10.6)	(8.7)	(10.7)	2.0	22.0	-	(6.0)
Sales to Public Supply/others	-	-	-	(0.2)	-	-	(0.2)
Losses in Distribution	(3.8)	(0.7)	(1.5)	-	(1.3)	-	(7.3)
Net Energy Supplied	80.6	13.1	44.4	26.8	22.1	0.3	187.3
(a) Process Energy							
Via Central Steam/Water Systems							
< 80°C	17.0	3.4	6.6	-	6.6	-	33.6
80-120°C	32.8	6.3	15.5	-	13.5	-	68.1
> 120°C	7.4	0.9	5.2	-	0.4	-	13.9
Via Direct-Process Plant (including refrigeration)							
< 200°C	2.3	0.1	4.0	7.6	-	0.3	14.3
200-400°C	1.4	-	7.2	0.4	-	-	9.0
Stationary Motive Power	0.9	-	-	12.8	-	-	13.7
(b) Space & Water Heating							
Via Central Steam/Water Systems	15.8	2.4	4.0	-	-	-	22.2
Via Local Boiler Plant	1.2	-	0.4	-	-	-	1.6
Via Direct-Acting Plant	0.5	-	0.5	1.6	1.6	-	4.2
(c) Lighting/Appliances	-	-	1.0	3.1	-	-	4.1
(d) Off-road Vehicles	1.3	-	-	1.3	-	-	2.6
Total	80.6	13.1	44.4	26.8	22.1	0.3	187.3
Primary Fuel Equivalent of Gross Energy Supplied	104.3	23.4	60.2	82.7#	18.9**	-	270.6

* Refrigerant (usually liquid nitrogen)

** Not included in total. Also includes steam associated with private generation.

# Excluding electricity for off-road vehicles.

2.6.2 Food, Drink and Tobacco

Table 32: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(1) The Dairy Industry

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross Energy Supplied	16.6	1.4	2.3	3.9	24.2
Losses in Distribution	(0.8)	(0.1)	(0.1)	-	(1.0)
Net Energy Supplied	15.8	1.3	2.2	3.9	23.2
Process Energy					
Via Central Steam/Water Systems					
< 80°C	5.8	0.6	1.0	-	7.4
80-120°C	4.9	0.5	0.7	-	6.1
Via Direct-Process Plant (including refrigeration)					
< 200°C	-	-	-	1.6	1.6
Stationary Motive Power	0.1	-	-	0.9	1.0
Space and Water Heating					
Via Central Steam/Water System	4.5	0.2	0.4	-	5.1
Via Local Boiler Plant	0.2	-	-	-	0.2
Via Direct-Acting Plant	0.1	-	-	0.2	0.3
Lighting/Appliances	-	-	0.1	0.2	0.3
Off-road Vehicles	0.2	-	-	1.0	1.2
	15.8	1.3	2.2	3.9	23.2

Table 33: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(2) Processed Foods

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Other*	Total
Gross Energy Supplied	9.1	0.3	5.1	3.2	0.3	18.0
Losses in Distribution	(0.5)	-	(0.2)	-	-	(0.7)
Net Energy Supplied	8.6	0.3	4.9	3.2	0.3	17.3
Process Energy						
Via Central Steam/Water Systems						
< 80°C	2.9	-	0.8	-	-	3.7
80-120°C	4.1	0.2	2.2	-	-	6.5
> 120°C	0.7	0.1	0.6	-	-	1.4
Via Direct-Process Plant (including refrigeration)						
< 200°C	-	-	0.1	1.9	0.3	2.3
200-400°C	-	-	0.6	-	-	0.6
Stationary Motive Power	-	-	-	0.7	-	0.7
Space and Water Heating						
Via Central Steam/Water System	0.6	-	0.4	-	-	1.0
Via Direct-Acting Plant	-	-	-	0.1	-	0.1
Lighting/Appliances	-	-	0.2	0.5	-	0.7
Off-road Vehicles	0.3	-	-	-	-	0.3
	8.6	0.3	4.9	3.2	0.3	17.3

* Refrigerant, usually liquid nitrogen or ammonia.

Table 34: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(3) Bakery Products

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross Energy Supplied	9.0	0.2	11.2	4.4	24.8
Losses in Distribution	(0.3)	-	(0.2)	-	(0.5)
Net Energy Supplied	8.7	0.2	11.0	4.4	24.3
Process Energy					
Via Central Steam/Water Systems					
< 80°C	0.7	-	0.5	-	1.2
80-120°C	2.1	0.1	1.9	-	4.1
Via Direct-Process Plant (including refrigeration)					
< 200°C	-	-	-	2.0	2.0
200-400°C	1.4	-	6.4	0.4	8.2
Stationary Motive Power	0.1	-	-	1.1	1.2
Space and Water Heating					
Via Central Steam/Water System	3.5	0.1	1.6	-	5.2
Via Local Boiler Plant	0.4	-	0.2	-	0.6
Via Direct-Acting Plant	0.2	-	0.2	0.3	0.7
Lighting/Appliances	-	-	0.2	0.5	0.7
Off-road Vehicles	0.3	-	-	0.1	0.4
	8.7	0.2	11.0	4.4	24.3

Table 35: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(4) Sugar and Sugar Products

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross Energy Supplied	13.5	10.3	7.7	1.6	-	33.1
Private Generation/CHP	(4.5)	(8.0)	(7.0)	1.3	14.3	(3.9)
Sales to Public Supply/others	-	-	-	(0.1)	-	(0.1)
Losses in Distribution	(0.4)	(0.1)	-	-	(0.8)	(1.3)
Net Energy Supplied	8.6	2.2	0.7	2.8	13.5	27.8
Process Energy						
Via Central Steam/Water Systems						
< 80°C	1.4	0.5	-	-	3.0	4.9
80-120°C	5.0	1.4	0.1	-	10.1	16.6
Via Direct-Process Plant (including refrigeration)						
< 200°C	0.1	-	0.4	0.7	-	1.2
Stationary Motive Power	0.1	-	-	1.5	-	1.6
Space and Water Heating						
Via Central Steam/Water System	1.8	0.3	-	-	-	2.1
Via Local Boiler Plant	0.1	-	-	-	-	0.1
Via Direct-Acting Plant	-	-	0.1	0.3	0.4	0.8
Lighting/Appliances	-	-	0.1	0.3	-	0.4
Off-road Vehicles	0.1	-	-	-	-	0.1
	8.6	2.2	0.7	2.8	13.5	27.8

2.6.2 Food, Drink and Tobacco

Table 36: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(5) The Drinks Industries

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross Energy Supplied	26.1	6.0	23.3	6.2	-	61.6
Private Generation/CHP	(3.0)	(0.7)	(2.3)	0.4	4.4	(1.2)
Sales to Public Supply/others	-	-	-	(0.1)	-	(0.1)
Losses in Distribution	(1.0)	(0.3)	(0.8)	-	(0.2)	(2.3)
Net Energy Supplied	22.1	5.0	20.2	6.5	4.2	58.0
Process Energy						
Via Central Steam/Water Systems						
< 80°C	3.3	1.0	3.6	-	1.3	9.2
80-120°C	9.8	2.7	9.2	-	2.1	23.8
> 120°C	2.9	0.1	2.8	-	-	5.8
Via Direct-Process Plant (including refrigeration)						
< 200°C	2.2	0.1	2.9	0.8	-	6.0
Stationary Motive Power	0.3	-	-	4.4	-	4.7
Space and Water Heating						
Via Central Steam/Water System	2.8	1.1	1.2	-	-	5.1
Via Local Boiler Plant	0.3	-	0.1	-	-	0.4
Via Direct-Acting Plant	0.2	-	0.2	0.4	0.8	1.6
Lighting/Appliances	-	-	0.2	0.8	-	1.0
Off-road Vehicles	0.3	-	-	0.1	-	0.4
	22.1	5.0	20.2	6.5	4.2	58.4

Table 37: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(6) Oils and Fats

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross Energy Supplied	6.7	1.6	3.7	1.3	1.4	14.7
Private Generation/CHP	(1.9)	-	(1.1)	0.2	2.2	(0.6)
Losses in Distribution	(0.2)	(0.1)	(0.1)	-	(0.2)	(0.6)
Net Energy Supplied	4.6	1.5	2.5	1.5	3.4	13.5
Process Energy						
Via Central Steam/Water Systems						
< 80°C	0.8	1.1	0.3	-	2.1	4.3
80-120°C	1.0	-	0.6	-	0.9	2.5
> 120°C	2.6	-	1.5	-	0.2	4.3
Via Direct-Process Plant (including refrigeration)						
< 200°C	-	-	-	0.4	-	0.4
Stationary Motive Power	0.1	-	-	0.9	-	1.0
Space and Water Heating						
Via Central Steam/Water System	0.1	0.4	0.1	-	0.2	0.8
Lighting/Appliances	-	-	-	0.2	-	0.2
	4.6	1.5	2.5	1.5	3.4	13.5

2.6.2 Food, Drink and Tobacco

Table 38: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(7) Miscellaneous Foods

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross Energy Supplied	12.6	2.7	2.6	3.8	-	21.7
Private Generation/CHP	(1.2)	-	(0.3)	0.1	1.1	(0.3)
Losses in Distribution	(0.5)	(0.1)	(0.1)	-	(0.1)	(0.8)
Net Energy Supplied	10.9	2.6	2.2	3.9	1.0	20.6
Process Energy						
Via Central Steam/Water Systems						
< 80°C	1.8	0.2	0.4	-	0.2	2.6
80-120°C	5.3	1.4	0.7	-	0.4	7.8
> 120°C	1.2	0.7	0.3	-	0.2	2.4
Via Direct-Process Plant						
< 200°C	-	-	0.2	0.2	-	0.4
200-400°C	-	-	0.2	-	-	0.2
Stationary Motive Power	0.2	-	-	2.8	-	3.0
Space and Water Heating						
Via Central Steam/Water System	2.1	0.3	0.2	-	-	2.6
Via Local Boiler Plant	0.2	-	0.1	-	-	0.3
Via Direct-Acting Plant	-	-	-	0.3	0.2	0.5
Lighting/Appliances	-	-	0.1	0.5	-	0.6
Off-road Vehicles	0.1	-	-	0.1	-	0.2
	10.9	2.6	2.2	3.9	1.0	20.6

Table 39: The Food, Drink and Tobacco Sector, Pattern of Energy Use, 1980

(8) The Tobacco Industry

	PJ - Delivered Energy			
	Liquids	Gases	Electricity	Total
Gross Energy Supplied	1.4	0.7	0.6	2.7
Losses in Distribution	(0.1)	-	-	(0.1)
Net Energy Supplied	1.3	0.7	0.6	2.6
Process Energy				
Via Central Steam/Water Systems				
< 80°C	0.3	-	-	0.3
80-120°C	0.6	0.1	-	0.7
Via Direct-Process Plant				
< 200°C	-	0.4	-	0.4
Stationary Motive Power	-	-	0.5	0.5
Space and Water Heating				
Via Central Steam/Water System	0.4	0.1	-	0.5
Lighting/Appliances	-	0.1	0.1	0.2
	1.3	0.7	0.6	2.6

2.6.3 The Engineering and Other Metal Trades Sector

(a) The Engineering Industry

72. The engineering industry is made up of some 43 individual subsectors producing a wide range of finished goods. These range from the heavy goods such as ships and vehicles to the lightweight products manufactured by the instrument engineering and parts of the electrical engineering sectors.

73. The nature of the energy requirements of these subsectors consequently varies widely but in general, there is a correlation between the physical size of the product and aggregate energy requirement, so that parts of the vehicles manufacture sector, ship building and parts of the mechanical engineering sector have the largest energy requirements.

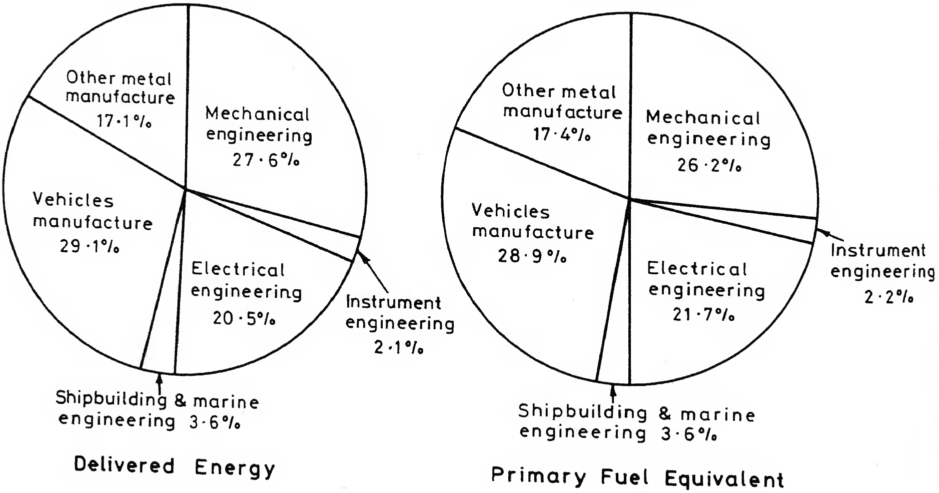
74. The industry consumed an estimated 303.4 PJ of conventional, recorded fuels/ energy carriers in 1980, this being equivalent to some 17% of total consumption by the other industry sector. Tables 40 and 41 and Figures 12 and 13 show aggregate energy use split by subsector and by fuel/ energy-carrier.

Table 40. Energy Use in Engineering, by Subsector, 1980

PJ

	Delivered Energy	Primary Fuel Equivalent
Mechanical engineering	83.7	127.0
Instrument engineering	6.5	10.9
Electrical engineering	62.1	105.2
Ship building and marine engineering	11.0	17.4
Vehicles manufacture	88.2	140.2
Other metal manufacture	51.9	84.8
	303.4	485.5

Figure 12. Energy Use in Engineering, by Subsector, 1980



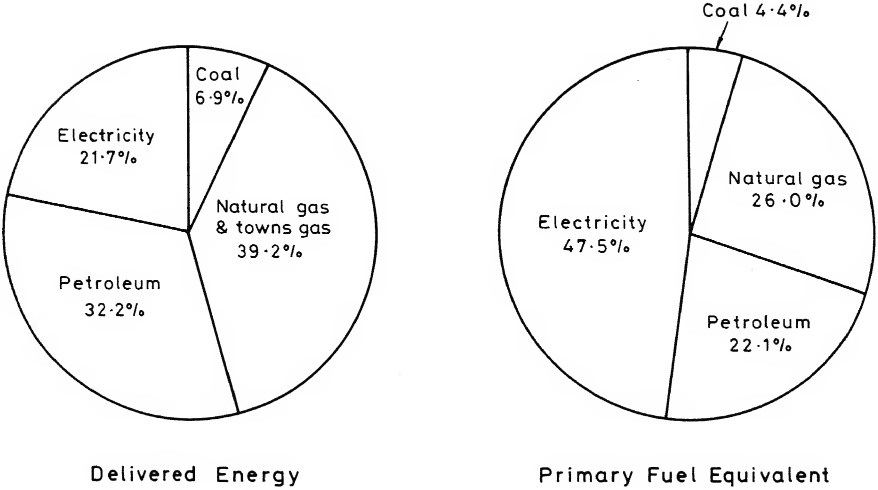
Delivered Energy

Primary Fuel Equivalent

Table 41. Energy Use in Engineering, by Fuel/Energy Carrier, 1980

	Delivered Energy	PJ Primary Fuel Equivalent
Coal	20.8	21.4
Natural gas	118.6	125.5
Towns gas	0.2	0.5
Petroleum	97.7	107.3
Electricity	66.1	230.8
	303.4	485.5

Figure 13. Energy Use in Engineering, by Fuel/Energy Carrier, 1980



75. Tables 43 to 49 give a detailed breakdown of how this energy was used in the engineering industry for 1980. The pattern of energy use is given for the whole sector in Table 43 and for the six sectors individually in Tables 44 to 49.

76. Gas was the major fuel used in the vehicle manufacturing, other metal manufacturing and electrical engineering sectors, where it has superseded oil as the main fuel used in central steam/water systems. Significant quantities of gas are used for high temperature heat treatment processes in all sectors. LPG, electricity and some coal are also used for this purpose. Drying, cooling and finishing of products also account for large amounts of energy and this is usually supplied via central steam/water systems.

2.6.3 Engineering

77. Space and water heating is, however, the dominant energy user in most instances: an estimated 58% of net energy consumed was used for space and water heating while this proportion was even higher for four out of the six individual sectors, see Table 42.

Table 42. Percentage of Net Energy Supplied Used for Space and Water Heating in the Engineering Industry, 1980

Mechanical engineering	64%
Instrument engineering	68%
Electrical engineering	61%
Ship building and marine engineering	70%
Vehicles manufacture	58%
Other metals manufacture	39%

78. Electricity was used primarily for motive power (including compressors) although in some subsectors e.g. jewellery and precious metals, ship building and others, electricity was used mainly for welding and heat treatment. A small amount of electricity (0.2 PJ) was generated within the vehicles manufacturing sector.

Table 43: The Engineering Industry, Pattern of Energy Use, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	97.7	20.8	118.8	66.8	-	304.1
Private generation/CHP	(0.1)	(0.4)	(1.4)	0.2	1.1	(0.6)
Losses in distribution	(3.7)	(0.9)	(4.1)	-	(0.1)	(8.8)
Net energy supplied	93.9	19.5	113.3	67.0	1.0	294.7
(a) Process Energy						
Via central steam/water system						
< 80°C	1.1	0.7	1.6	-	-	3.4
80-120°C	4.5	2.9	5.8	-	0.2	13.4
> 120°C	1.0	0.3	1.1	-	0.1	2.5
Via direct-process plant						
< 200°C	1.2	-	2.5	-	-	3.7
200-400°C	-	-	4.0	0.2	-	4.2
> 400°C	4.0	1.3	18.0	11.2	-	34.5
Stationary motive power	4.7	-	1.0	43.4	-	49.1
(b) Space and Water Heating						
Via central steam/water system	65.8	14.3	61.4	-	-	141.5
Via local boiler plant	3.4	-	4.3	-	-	7.7
Via direct-acting plant	7.5	-	9.4	3.3	0.7	20.9
(c) Lighting/Appliances	-	-	4.2	8.2	-	12.4
(d) Off-road Vehicles	0.7	-	-	0.7		1.4
	93.9	19.5	113.3	67.0	1.0	294.7

Table 44: The Engineering Industry, Pattern of Energy Use, 1980

(1) Mechanical Engineering

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	34.7	6.4	27.3	15.5	83.9
Losses in distribution	(1.3)	(0.2)	(1.0)	-	(2.5)
Net energy supplied	33.4	6.2	26.3	15.5	81.4
Process Energy					
Via central steam/water system					
< 80°C	-	0.3	0.2	-	0.5
80-120°C	0.4	1.3	0.8	-	2.5
Via direct-process plant					
< 200°C	0.2	-	1.6	-	1.8
200-400°C	-	-	0.8	-	0.8
> 400°C	1.8	0.9	3.2	1.2	7.1
Stationary motive power	1.4	-	0.3	12.2	13.9
Space and Water Heating					
Via central steam/water system	25.4	3.7	13.2	-	42.3
Via local boiler plant	1.2	-	1.6	-	2.8
Via direct-acting plant	2.8	-	3.6	0.2	6.6
Lighting/appliances	-	-	1.0	1.7	2.7
Off-road vehicles	0.2	-	-	0.2	0.4
	33.4	6.2	26.3	15.5	81.4

Table 45: The Engineering Industry, Pattern of Energy Use, 1980

(2) Instrument Engineering

	PJ - Delivered Energy			
	Liquids	Gases	Electricity	Total
Gross energy supplied	2.2	2.7	1.6	6.5
Losses in distribution	(0.1)	(0.1)	-	(0.2)
Net energy supplied	2.1	2.6	1.6	6.3
Process Energy				
Via central steam/water systems 80-120°C	0.2	0.1	-	0.3
Via direct-process plant > 400°C	0.1	0.2	0.2	0.5
Stationary motive power	0.1	-	0.8	0.9
Space and Water Heating				
Via central steam/water systems	1.7	2.1	-	3.8
Via direct-acting plant	-	0.1	0.4	0.5
Lighting/appliances	-	0.1	0.2	0.3
	2.1	2.6	1.6	6.3

Table 46: The Engineering Industry, Pattern of Energy Use, 1980

(3) Electrical Engineering

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	20.3	1.7	24.2	16.1	62.3
Losses in distribution	(0.8)	(0.1)	(0.9)	-	(1.8)
Net energy supplied	19.5	1.6	23.3	16.1	60.5
Process Energy					
Via central steam/water system					
< 80°C	0.3	0.1	0.3	-	0.7
80-120°C	0.5	0.4	0.7	-	1.6
Via direct-process plant					
200-400°C	-	-	0.3	-	0.3
> 400°C	0.7	-	2.0	0.9	3.6
Stationary motive power	1.2	-	0.3	11.2	12.7
Space and Water Heating					
Via central steam/water system	13.8	1.1	16.8	-	31.7
Via local boiler plant	0.9	-	0.5	-	1.4
Via direct-acting plant	2.0	-	1.1	1.0	4.1
Lighting/appliances	-	-	1.3	2.8	4.1
Off-road vehicles	0.1	-	-	0.2	0.3
	19.5	1.6	23.3	16.1	60.5

Table 47: The Engineering Industry, Pattern of Energy Use, 1980

(4) Shipbuilding and Marine Engineering

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	6.5	0.1	2.1	2.3	11.0
Losses in distribution	(0.2)	-	(0.1)	-	(0.3)
Net energy supplied	6.3	0.1	2.0	2.3	10.7
Process Energy					
Via central steam/water system 80-120°C	0.1	-	-	-	0.1
Via direct-process plant > 400°C	0.5	-	0.8	1.1	2.4
Stationary motive power	-	-	-	0.4	0.4
Space and Water Heating					
Via central steam/water system	5.3	0.1	1.0	-	6.4
Via local boiler plant	0.2	-	0.1	-	0.3
Via direct-acting plant	0.2	-	0.1	0.5	0.8
Lighting/appliances	-	-	-	0.3	0.3
	6.3	0.1	2.0	2.3	10.7

Table 48: The Engineering Industry, Pattern of Energy Use, 1980

(5) Vehicles Manufacture

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	24.3	11.4	33.6	19.1	-	88.4
Private generation/CHP	(0.1)	(0.4)	(1.4)	0.2	1.1	(0.6)
Losses in distribution	(0.9)	(0.5)	(1.0)	-	(0.1)	(2.5)
Net energy supplied	23.3	10.5	31.2	19.3	1.0	85.3
Process Energy						
Via central steam/water system						
< 80°C	0.3	0.2	0.4	-	-	0.9
80-120°C	1.5	0.7	1.4	-	0.2	3.8
> 120°C	0.7	0.3	0.7	-	0.1	1.8
Via direct-process plant						
< 200°C	0.9	-	0.3	-	-	1.2
200-400°C	-	-	1.0	-	-	1.0
> 400°C	0.5	0.3	4.5	4.2	-	9.5
Stationary motive power	1.3	-	0.3	12.1	-	13.7
Space and Water Heating						
Via central steam/water system	14.9	9.0	16.1	-	-	40.0
Via local boiler plant	0.9	-	1.7	-	-	2.6
Via direct-acting plant	2.1	-	3.7	0.7	0.7	7.2
Lighting/appliances	-	-	1.1	2.1	-	3.2
Off road vehicles	0.2	-	-	0.2	-	0.4
	23.3	10.5	31.2	19.3	1.0	85.3

Table 49. The Engineering Industry, Pattern of Energy Use, 1980

(6) Other Metal Manufacture

	PJ – Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	9.7	1.2	28.9	12.2	52.0
Losses in distribution	(0.4)	(0.1)	(1.0)	–	(1.5)
Net energy supplied	9.3	1.1	27.9	12.2	50.5
Process Energy					
Via central steam/water system					
< 80°C	0.5	0.1	0.7	–	1.3
80–120°C	1.8	0.5	2.8	–	5.1
> 120°C	0.3	–	0.4	–	0.7
Via direct-process plant					
< 200°C	0.1	–	0.6	–	0.7
200–400°C	–	–	1.9	0.2	2.1
> 400°C	0.4	0.1	7.3	3.6	11.4
Stationary motive power	0.7	–	0.1	6.7	7.5
Space and Water Heating					
Via central steam/water system	4.7	0.4	12.2	–	17.3
Via local boiler plant	0.2	–	0.4	–	0.6
Via direct-acting plant	0.4	–	0.8	0.5	1.7
Lighting/appliances	–	–	0.7	1.1	1.8
Off-road vehicles	0.2	–	–	0.1	0.3
	9.3	1.1	27.9	12.2	50.5

2.6.3 Other Metal Trades

(b) Other Metal Trades

79. The other metal trades sector is made up of the aluminium, copper, lead, zinc and other non-ferrous metals and alloys manufacturing industries. The sector as a whole used 91.2 PJ of conventional, recorded fuels and energy carriers in 1980, this total amounting to just over 5% of total industrial energy consumption (excluding the iron and steel industry).

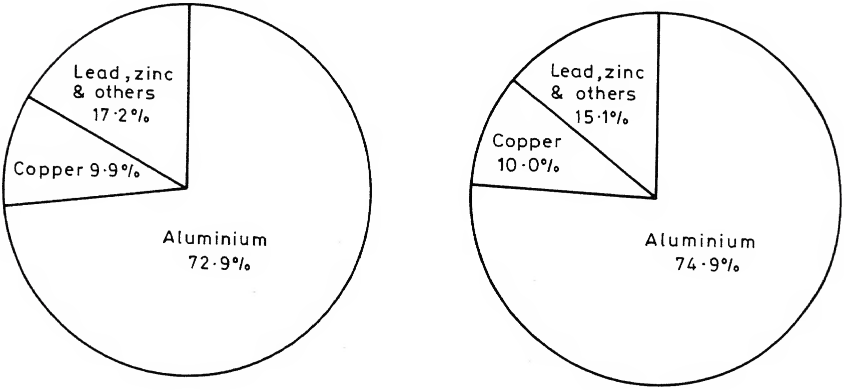
80. Aluminium and aluminium alloys accounted for 66.5 PJ of energy consumption, equivalent to 73% of total sectoral energy use. Copper and copper alloys used some 9 PJ of delivered energy, while other non-ferrous metals consumed an estimated 15.7 PJ.

81. Tables 50 and 51 and Figures 14 and 15 show sectoral energy use by subsector and by fuel/energy-carrier.

Table 50. Energy Use in the Other Metals Trades, by Subsector, 1980

	PJ	
	Delivered Energy	Primary Fuel Equivalent
Aluminium and aluminium alloys	66.5	112.2
Copper, brass and other copper alloys	9.0	15.0
Lead, zinc and other non-ferrous metals	15.7	22.6
	91.2	149.8

Figure 14. Energy Use in Other Metals Trades, by Subsector, 1980



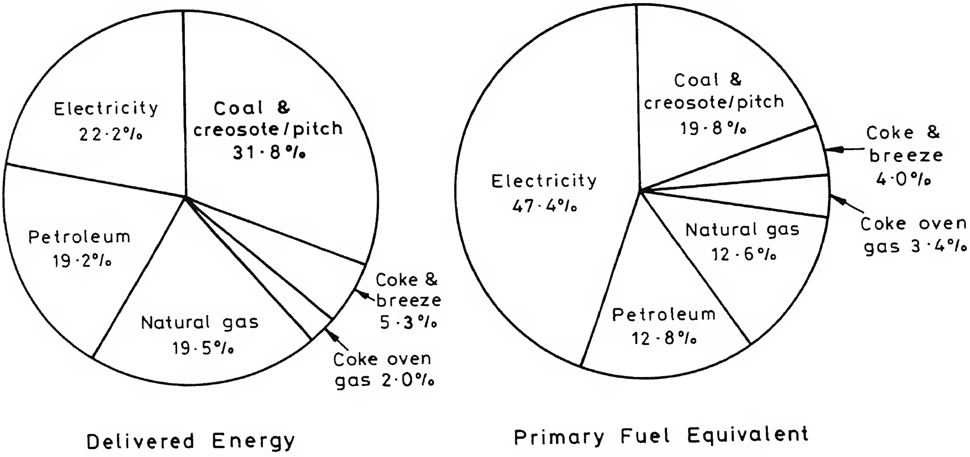
Delivered Energy

Primary Fuel Equivalent

Table 51. Energy Use in the Other Metals Trades, by Fuel/Energy Carrier, 1980

	PJ	
	Delivered Energy	Primary Fuel Equivalent
Coal	28.9	29.7
Coke and breeze	4.8	6.0
Coke oven gas	1.8	5.1
Natural gas	17.8	18.8
Petroleum	17.5	19.2
Electricity	20.3	70.9
Creosote/pitch	0.1	0.1
	91.2	149.8

Figure 15. Energy Use in Other Metals Trades, by Fuel/Energy Carrier, 1980



82. Energy use in the aluminium industry is dominated by the electrochemical smelting process, which accounts for 85% of total electricity consumption and 46% of net energy consumed by the industry. Approximately 42% of the total electricity consumed was generated within the industry itself, using 29.2 PJ of fuels in the process.

83. The secondary refining of aluminium and semi-fabrication of aluminium products also account for large amounts of energy (an estimated 12.4 PJ in total), this being consumed by the various melting, rolling and extrusion processes in the industry.

2.6.3 Other Metal Trades

84. Virtually no primary smelting of copper is carried out in the UK, so that the furnaces used in the refining of copper scrap and imported unrefined primary metal and in the semi-fabrication of copper and copper alloys (such as brass) are the dominant energy users. Process energy in all accounts for an estimated 89% of total energy consumption.

85. The smelting, processing and refining of lead and zinc used 12.8 PJ of energy in 1980. The smelting and galvanising of zinc alone used some 7.5 PJ in all with the lead refining and semi-fabrication processes accounting for a further 3.2 PJ. The processing of other non- ferrous metals, notably tin and nickel used some 2.9 PJ of energy in 1980.

86. Tables 52 to 55 show a detailed breakdown of the pattern of energy use in the other metal trades sector and Table 56 shows the pattern for the engineering and other metal trades sector as a whole.

Table 52: Other Metal Trades, Pattern of Energy Use, 1980

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	17.5	33.8	19.6	20.5	91.4
Private generation	(2.1)	(21.4)	(5.7)	11.7	(17.5)
Sales to public supply/others	-	-	-	(1.3)	(1.3)
Losses in distribution	(0.2)	-	-	-	(0.2)
Net energy supplied	15.2	12.4	13.9	30.9	72.4
(a) Process Energy					
Via direct-process plant					
< 200°C	0.5	-	0.3	-	0.8
200-400°C	0.8	1.0	0.5	-	2.3
> 400°C	11.9	11.1	11.2	3.4	37.6
Electrochemical	-	-	-	22.4	22.4
Stationary motive power	-	-	-	3.8	3.8
(b) Space and Water Heating					
Via central steam/water system	2.0	0.3	1.7	-	4.0
(c) Lighting/appliances	-	-	0.2	1.1	1.3
(d) Off-road vehicles	-	-	-	0.2	0.2
	15.2	12.4	13.9	30.9	72.4

2.6.3 Other Metal Trades

Table 53: Other Metal Trades, Pattern of Energy Use, 1980

(1) Aluminium and Aluminium Alloys

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	10.5	28.4	11.9	15.9	66.7
Private generation	(2.1)	(21.4)	(5.7)	11.7	(17.5)
Sales to public supply/others	-	-	-	(1.3)	(1.3)
Losses in distribution	(0.1)	-	-	-	(0.1)
Net energy supplied	8.3	7.0	6.2	26.3	47.8
Process Energy					
Via direct-process plant > 400°C	7.1	7.0	5.3	2.0	21.4
Electrochemical	-	-	-	22.2	22.2
Stationary motive power	-	-	-	1.3	1.3
Space and Water Heating					
Via central steam/water system	1.2	-	0.8	-	2.0
Lighting/appliances	-	-	0.1	0.6	0.7
Off-road vehicles	-	-	-	0.2	0.2
	8.3	7.0	6.2	26.3	47.8

Table 54: Other Metal Trades, Pattern of Energy Use, 1980

(2) Copper and Copper Alloys

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	1.9	0.6	4.3	2.2	9.0
Losses in distribution	-	-	-	-	-
Net energy supplied	1.9	0.6	4.3	2.2	9.0
Process Energy					
Via direct-process plant > 400°C	1.7	0.5	3.8	1.1	7.1
Electrochemical	-	-	-	0.2	0.2
Stationary motive power	-	-	-	0.7	0.7
Space and Water Heating					
Via central steam/water system	0.2	0.1	0.4	-	0.7
Lighting/appliances	-	-	0.1	0.2	0.3
	1.9	0.6	4.3	2.2	9.0

2.6.3 Other Metal Trades

Table 55: Other Metal Trades, Pattern of Energy Use, 1980

(3) Lead, Zinc and Others

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	5.1	4.8	3.4	2.4	15.7
Losses in distribution	(0.1)	-	-	-	(0.1)
Net energy supplied	5.0	4.8	3.4	2.4	15.6
Process Energy					
Via direct-process plant					
< 200°C	0.5	-	0.3	-	0.8
200-400°C	0.8	1.0	0.5	-	2.3
> 400°C	3.1	3.6	2.1	0.3	9.1
Stationary motive power	-	-	-	1.8	1.8
Space and Water Heating					
Via central steam/water system	0.6	0.2	0.5	-	1.3
Lighting/appliances	-	-	-	0.3	0.3
	5.0	4.8	3.4	2.4	15.6

2.6.3 Engineering and Other Metal Trades

Table 56: The Engineering and Other Metal Trades Sector, Pattern of Energy Use, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	115.2	54.6	138.4	87.3	-	395.5
Private generation/CHP	(2.2)	(21.8)	(7.1)	11.9	1.1	(18.1)
Sales to public supply/others	-	-	-	(1.3)	-	(1.3)
Losses in distribution	(3.9)	(0.9)	(4.1)	-	(0.1)	(9.0)
Net energy supplied	109.1	31.9	127.2	97.9	1.0	367.1
(a) Process Energy						
Via central steam/water system						
< 80°C	1.1	0.7	1.6	-	-	3.4
80-120°C	4.5	2.9	5.8	-	0.2	13.4
> 120°C	1.0	0.3	1.1	-	0.1	2.5
Via direct-process plant						
< 200°C	1.7	-	2.8	-	-	4.5
200-400°C	0.8	1.0	4.5	0.2	-	6.5
> 400°C	15.9	12.4	29.2	14.6	-	72.1
Electrochemical	-	-	-	22.4	-	22.4
Stationary motive power	4.7	-	1.0	47.2	-	52.9
(b) Space and Water Heating						
Via central steam/water system	67.8	14.6	63.1	-	-	145.5
Via local boiler plant	3.4	-	4.3	-	-	7.7
Via direct-acting plant	7.5	-	9.4	3.3	0.7	20.9
(c) Lighting/Appliances	-	-	4.4	9.3	-	13.7
(d) Off-road Vehicles	0.7	-	-	0.9	-	1.6
TOTAL	109.1	31.9	127.2	97.9	1.0	367.1
Primary Fuel Equivalent of Gross Energy Supplied	126.5	57.2	149.9	301.7#	-	635.3

# Excludes electricity for off-road vehicles.

2.6.4 The Textiles, Leather and Clothing Sector

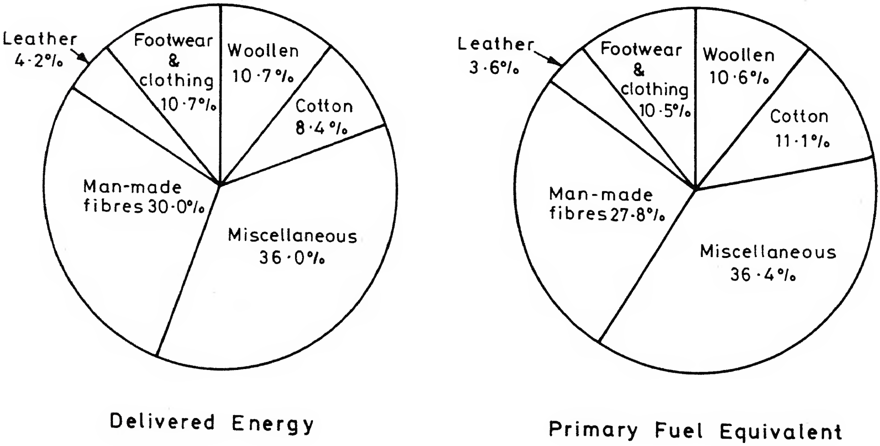
87. The textiles, leather and clothing sector consumed 98.4 PJ of conventional, recorded fuels/ energy carriers in 1980, this being equivalent to 6% of total consumption by the other industry sector.

88. Tables 57 and 58 and Figures 16 and 17 show total energy use split both by subsector and by fuel/ energy carrier:

Table 57. Energy Use in Textiles, Leather and Clothing by Subsector, 1980

	PJ Delivered Energy	 Primary Fuel Equivalent
Woollen and worsted	10.5	15.6
Cotton spinning and weaving	8.3	16.2
Miscellaneous textiles (inc textile finishing, knitted goods, carpets and jute)	35.4	53.3
Man-made fibres	29.5	40.8
Leather and leather goods	4.1	5.3
Footwear and clothing	10.6	15.3
	98.4	146.5

Figure 16. Energy Use in Textiles, Leather and Clothing, by Subsector, 1980

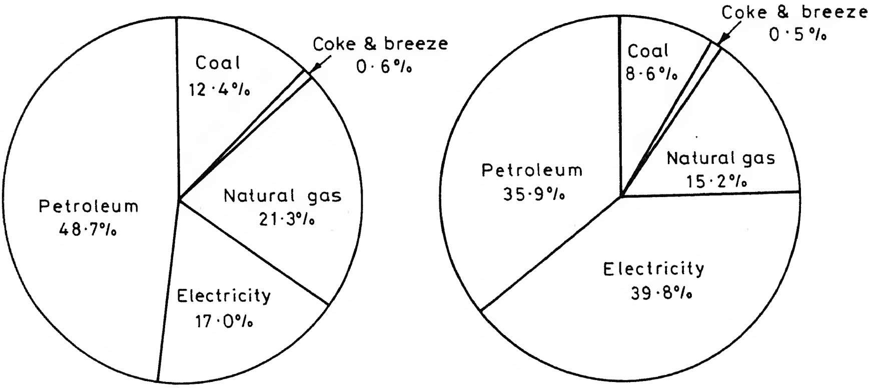


2.6.4 Textiles, Leather and Clothing

Table 58. Energy Use in Textiles, Leather and Clothing, by Fuel/Energy Carrier, 1980

	PJ	
	Delivered Energy	Primary Fuel Equivalent
Coal	12.2	12.6
Coke and breeze	0.6	0.8
Natural gas	21.0	22.2
Electricity	16.7	58.3
Petroleum	47.9	52.6
	98.4	146.5

Figure 17. Energy Use in Textiles, Leather and Clothing, by Fuel/Energy Carrier, 1980



Delivered Energy

Primary Fuel Equivalent

89. Energy use in the sector as a whole is dominated by the use of oil, coal and gas for the production of steam and hot water, either for process energy or space heating, so that boilers use an estimated 74% of the gross energy supplied to the sector if losses and the use of fuels for CHP purposes are included, i.e. 73.1 PJ.

90. Oil is the main fuel used, principally due to the large requirement of the man-made fibres industry and the textile finishing sector.

2.6.4 Textiles, Leather and Clothing

91. The sector can be divided into those industries which have a high process energy requirement (usually for washing, dyeing, drying and cleaning) and those which have a relatively large space heating component i.e. those principally involved in the spinning and making-up of garments. These characteristics are brought out in Table 59.

Table 59. Proportion of Net Energy Supplied for Space and Water Heating in Textiles, Leather and Clothing, 1980

Woollen and worsted	33%
Cotton spinning and weaving	55%
Miscellaneous textiles	24%
Man-made fibres	18%
Leather and leather goods	30%
Footwear and clothing	72%

92. In the two industries with the largest space and water heating components electricity accounted for a higher than average proportion of process energy: 84% in cotton (mainly for spinning and weaving operations) and 52% in footwear/clothing compared with 25% for the whole sector.

93. Direct-process plant used was mainly various forms of drying and cleaning equipment, e.g. ovens, bakers, stenters and most of the above operations were carried out by the use of steam-based plant.

94. Electricity was used predominantly for motive power of one form or another (including compressed air). The man-made fibres industry generated an estimated 0.8 PJ during 1980, equivalent to 18% of total electricity requirements.

95. Table 60 describes total sectoral energy use while Tables 61 to 66 outline the pattern of energy use for each subsector.

Table 60: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

	PJ – Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	47.9	12.8	21.0	17.0	–	98.7
Private generation/CHP	(5.7)	(4.1)	(0.6)	0.8	7.1	(2.5)
Losses in distribution	(1.9)	(0.3)	(0.8)	–	(0.3)	(3.3)
Net energy supplied	40.3	8.4	19.6	17.8	6.8	92.9
(a) Process Energy						
Via central steam/water system						
< 80°C	4.4	1.2	2.2	–	0.4	8.2
80-120°C	8.6	1.8	2.7	–	2.7	15.8
> 120°C	9.6	2.1	4.6	–	2.3	18.6
Via direct-process plant						
< 200°C	0.9	–	0.8	0.5	–	2.2
200-400°C	0.5	–	0.4	0.1	–	1.0
Stationary motive power	–	–	–	14.1	–	14.1
(b) Space and Water Heating						
Via central steam/water system	13.8	2.7	6.0	–	–	22.5
Via local boiler plant	2.5	0.6	1.3	–	–	4.4
Via direct-acting plant	–	–	0.2	1.1	1.4	2.7
(c) Lighting/Appliances	–	–	1.4	1.7	–	3.1
(d) Off-road Vehicles	–	–	–	0.3	–	0.3
TOTAL	40.3	8.4	19.6	17.8	6.8	92.9
Primary Fuel Equivalent of Gross Energy Supplied	52.6	13.4	22.2	58.3#	–	146.5

# Excluding electricity for off-road vehicles

Table 61: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(1) Woollen and Worsted

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	4.3	2.4	1.6	2.2	10.5
Losses in distribution	(0.2)	(0.1)	(0.1)	-	(0.4)
Net energy supplied	4.1	2.3	1.5	2.2	10.1
Process Energy					
Via central steam/water systems					
< 80°C	0.5	0.3	0.1	-	0.9
80-120°C	1.3	0.7	0.3	-	2.3
> 120°C	0.7	0.4	0.1	-	1.2
Via direct-process plant					
< 200°C	-	-	0.1	-	0.1
Stationary motive power	-	-	-	1.8	1.8
Space and Water Heating					
Via central steam/water systems	1.3	0.9	0.7	-	2.9
Via local boiler plant	0.3	-	0.1	-	0.4
Via direct-acting plant	-	-	-	0.1	0.1
Lighting/appliances	-	-	0.1	0.3	0.4
	4.1	2.3	1.5	2.2	10.1

Table 62: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(2) Cotton Spinning and Weaving

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	3.2	0.8	1.3	3.1	8.4
Losses in distribution	(0.2)	–	(0.1)	–	(0.3)
Net energy supplied	3.0	0.8	1.2	3.1	8.4
Process Energy					
Via central steam/water systems					
< 80°C	0.1	–	–	–	0.1
80-120°C	0.1	0.1	0.1	–	0.3
> 120°C	0.1	–	–	–	0.1
Stationary motive power	–	–	–	2.6	2.6
Space and Water Heating					
Via central steam/water systems	2.3	0.7	0.8	–	3.8
Via local boiler plant	0.4	–	0.1	–	0.5
Via direct-acting plant	–	–	0.1	0.2	0.3
Lighting/appliances	–	–	0.1	0.2	0.3
Off-road vehicles	–	–	–	0.1	0.1
	3.0	0.8	1.2	3.1	8.4

Table 63: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(3) Miscellaneous Textiles (including Finishing, Knitted Goods, Carpets and Jute)

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	12.8	4.2	12.6	5.9	35.5
Losses in distribution	(0.6)	(0.2)	(0.4)	-	1.2
Net energy supplied	12.2	4.0	12.2	5.9	34.3
Process Energy					
Via central steam/water systems					
< 80°C	1.2	0.5	1.4	-	6.1
80-120°C	2.4	0.8	1.9	-	2.1
> 120°C	4.5	1.6	4.2	-	10.3
Via direct-process plant					
< 200°C	0.4	-	0.3	0.1	0.8
200-400°C	0.5	-	0.4	0.1	1.0
Stationary motive power	-	-	-	4.8	4.8
Space and Water Heating					
Via central steam/water systems	2.7	0.5	2.9	-	6.1
Via local boiler plant	0.5	0.6	0.6	-	1.7
Via direct-acting plant	-	-	0.1	0.3	0.4
Lighting/appliances	-	-	0.4	0.5	0.9
Off-road vehicles	-	-	-	0.1	0.1
	12.2	4.0	12.2	5.9	34.3

Table 64: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(4) Man-made Fibres

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	19.3	4.4	2.1	3.8	-	29.6
Private generation/CHP	(5.7)	(4.1)	(0.6)	0.8	7.1	(2.5)
Losses in distribution	(0.6)	-	(0.1)	-	(0.3)	(1.0)
Net energy supplied	13.0	0.3	1.4	4.6	6.8	26.1
Process Energy						
Via central steam/water systems						
< 80°C	0.5	-	-	-	0.4	0.9
80-120°C	4.8	0.2	0.4	-	2.7	8.1
> 120°C	4.3	0.1	0.3	-	2.3	7.0
Via direct-process plant						
< 200°C	0.5	-	0.3	0.2	-	1.0
Stationary motive power	-	-	-	3.7	-	3.7
Space and Water Heating						
Via central steam/water systems	2.5	-	0.2	-	-	2.7
Via local boiler plant	0.4	-	0.1	-	-	0.5
Via direct-acting plant	-	-	-	0.2	1.4	1.6
Lighting/Appliances	-	-	0.1	0.4	-	0.5
Off-road vehicles	-	-	-	0.1	-	0.1
	13.0	0.3	1.4	4.6	6.8	26.1

Table 65: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(5) Leather and Leather Goods

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	2.4	0.5	0.8	0.4	4.1
Losses in distribution	(0.1)	-	-	-	(0.1)
Net energy supplied	2.3	0.5	0.8	0.4	4.0
Process Energy					
Via central steam/water systems < 80°C	1.5	0.3	0.4	-	2.2
Via direct-process plant < 200°C	-	-	0.1	0.1	0.2
Stationary motive power	-	-	-	0.2	0.2
Space and Water Heating					
Via central steam/water systems	0.7	0.2	0.2	-	1.1
Via local boiler plant	0.1	-	-	-	0.1
Lighting/appliances	-	-	0.1	0.1	0.2
	2.3	0.5	0.8	0.4	4.0

Table 66: Textiles, Leather and Clothing, Pattern of Energy Use, 1980

(6) Footwear and Clothing

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	5.9	0.5	2.6	1.6	10.6
Losses in distribution	(0.2)	-	(0.1)	-	(0.3)
Net energy supplied	5.7	0.5	2.5	1.6	10.3
Process Energy					
Via central steam/water systems < 80°C	0.6	0.1	0.3	-	1.0
Via direct-process plant < 200°C	-	-	-	0.1	0.1
Stationary motive power	-	-	-	1.0	1.0
Space and Water Heating					
Via central steam/water systems	4.3	0.4	1.2	-	5.9
Via local boiler plant	0.8	-	0.4	-	1.2
Via direct-acting plant	-	-	-	0.3	0.3
Lighting/appliances	-	-	0.6	0.2	0.8
	5.7	0.5	2.5	1.6	10.3

2.6.5 The Paper, Printing and Stationery Sector

96. The paper, printing and stationery sector consumed 116.5 PJ of conventional, recorded fuels/energy carriers in 1980, equivalent to approximately 7% of total industrial energy use (excluding iron and steel).

97. Although the range of final products of the sector is large, ranging from light crêpe tissues to heavy packaging materials, the industry is fairly homogeneous in that paper mills generally manufacture the whole range of intermediate products which are transported to converting mills for conversion to the finished papers. (A small number of integrated mills do, in fact, carry out the full range of manufacturing processes, including conversion.)

98. As such, it is difficult to identify accurately the pattern of energy use attributable to an individual paper and board product. For this reason, the pattern of energy use has been estimated for the paper and board industry as a whole, see Table 70. Since the printing and publishing industry is distinct from the paper and board manufacturing sector, patterns of energy use can be separated and are given in Table 71.

99. Tables 67 and 68 and Figures 18 and 19 show the approximate split of aggregate energy consumption attributable to the final products of the sector and aggregate energy consumption split by individual fuel/energy carrier.

100. The paper and board industry is essentially a central steam/water based industry with larger requirements for steam and water in the paper and board manufacturing mills than in the converting mills, where space heating is more important in terms of energy use. An estimated 85% of gross energy supplied to the industry passed through boiler systems (including the large amounts of fuels used in CHP schemes).

101. Some 80% of the process heat requirements were consumed in the various drying proceses (including an estimated 0.4 PJ used for directly-fired drying). The remainder was consumed in the pulping, refining, pulp cleaning, waste treatment and finishing/converting processes. The industry has a large electricity requirement, consumed mostly in the refining process for driving the large conical barred shells for processing paper fibre.

102. Given the large steam and electrical energy needs of the paper mills, it is not surprising that there are so many CHP schemes within the industry. An estimated 5.8 PJ of electricity was self-generated in 1980, equivalent to 33% of total electricity used. CHP schemes in all consumed 58 PJ of fuels in 1980, yielding an overall electricity and steam production efficiency of 73%.

103. In contrast to the paper and board industry, the printing and publishing subsector used 14.9 PJ of fuels/energy carriers in 1980, mostly for space heating requirements (some 70% of gross energy supplied). Small amounts of fuels were used for drying purposes and in furnaces, with most of the rest of non-space heating requirements, i.e. motive power, lighting and appliance usage, being met by purchased electricity.

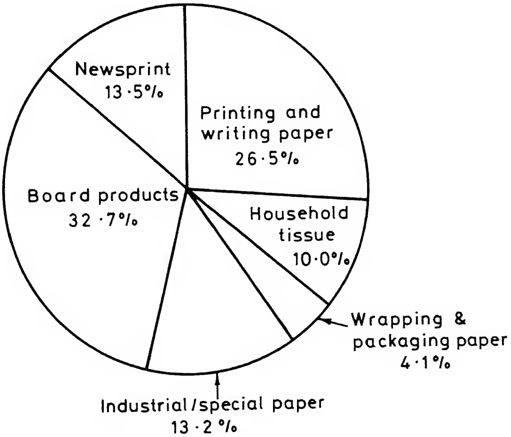
104. Tables 69 to 71 give full details of the pattern of energy use for the sector.

Table 67. Energy Consumption in the Paper and Board Industry Split by Final Product, 1980

	PJ Delivered Energy*
Printing and writing paper	26.9
Household tissue	10.2
Wrapping and packaging paper	4.2
Industrial and special paper	13.4
Board products	33.2
Newsprint	13.7
	101.6

* Primary fuel equivalents are not estimated as it is difficult to attribute consumption of individual fuels to specific products.

Figure 18. Energy Consumption in the Paper and Board Industry Split by Final Product, 1980



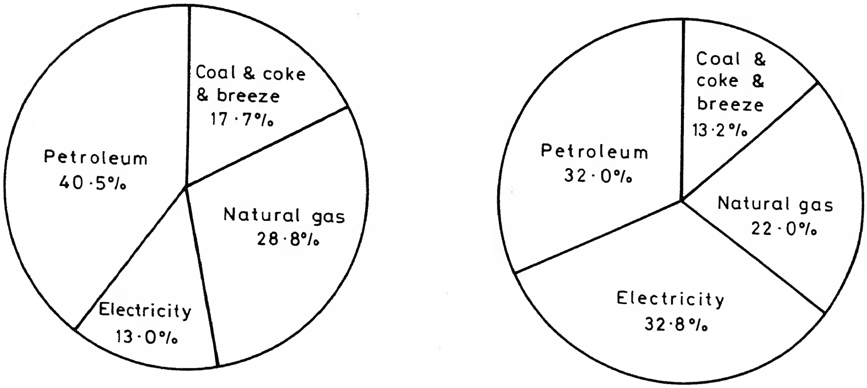
2.6.5 Paper, Printing and Stationery

Table 68. Energy Consumption in the Paper, Printing and Stationery Sector Split by Fuel/Energy Carrier, 1980

PJ

	Delivered Energy	Primary Fuel Equivalent
(a) Paper and Board Industry		
Coal	20.1	20.7
Coke and breeze	0.4	0.5
Natural gas	26.7	28.3
Electricity	11.9	41.5
Petroleum	42.5	46.7
	101.6	137.7
(b) Printing and Publishing		
Coal	0.1	0.1
Natural gas	6.9	7.3
Electricity	3.3	11.5
Petroleum	4.6	5.1
	14.9	24.0
Total sector	116.5	161.7

Figure 19. Energy Consumption in the Paper, Printing and Stationery Sector, Split by Fuel/Energy Carrier, 1980



Delivered Energy

Primary Fuel Equivalent

Table 69: Paper, Printing and Stationery, Pattern of Energy Use, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	47.1	20.6	33.6	15.5	-	116.8
Private generation/ CHP	(21.7)	(17.8)	(18.5)	5.8	36.8	(15.4)
Sales to public supply/ others	-	-	-	(0.4)	-	(0.4)
Losses in distribution	(1.1)	(0.1)	(0.5)	-	(1.9)	(3.6)
Net energy supplied	24.3	2.7	14.6	20.9	34.9	97.4
(a) Process Energy						
Via central steam/ water systems						
< 80° C	0.7	0.1	0.2	-	0.9	1.9
80-120° C	2.9	0.3	1.2	-	7.0	11.4
> 120° C	10.7	1.6	4.8	-	19.4	36.5
Via direct-process plant						
< 200° C	0.3	-	0.2	0.3	-	0.8
Stationary motive power	-	-	-	17.0	-	17.0
(b) Space and Water Heating						
Via central steam/ water systems	5.1	0.7	3.6	-	-	9.4
Via local boiler plant	0.8	-	0.5	-	-	1.3
Via direct-acting plant	3.8	-	3.3	1.7	7.6	16.4
(c) Lighting/ Appliances	-	-	0.8	1.6	-	2.4
(d) Off-road Vehicles	-	-	-	0.3	-	0.3
TOTAL	24.3	2.7	14.6	20.9	34.9	97.4
Primary Fuel Equivalent of Gross Energy Supplied	51.8	21.3	35.6	53.0#	-	161.7

Excluding electricity for off-road vehicles.

2.6.5 Paper, Printing and Stationery

Table 70: Paper, Printing and Stationery, Pattern of Energy Use, 1980

(1) The Paper and Board Industry

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	42.5	20.5	26.7	12.1	-	101.8
Private generation/ CHP	(21.7)	(17.8)	(18.5)	5.8	36.8	(15.4)
Sales to public supply/ others	-	-	-	(0.4)	-	(0.4)
Losses in distribution	(1.0)	(0.1)	(0.3)	-	(1.9)	(3.3)
Net energy supplied	19.8	2.6	7.9	17.5	34.9	82.7
(a) Process Energy						
Via central steam/ water systems						
< 80° C	0.7	0.1	0.2	-	0.9	1.9
80-120° C	2.7	0.3	1.0	-	7.0	11.0
> 120° C	10.7	1.6	4.8	-	19.4	36.5
Via direct-process plant						
< 200° C	0.2	-	0.1	0.1	-	0.4
Stationary motive power	-	-	-	15.0	-	15.0
(b) Space and Water Heating						
Via central steam/ water systems	2.9	0.6	0.5	-	-	4.0
Via local boiler plant	0.4	-	0.1	-	-	0.5
Via direct-acting plant	2.2	-	0.9	1.3	7.6	12.0
(c) Lighting/ Appliances	-	-	0.3	0.9	-	1.2
(d) Off-road Vehicles	-	-	-	0.2	-	0.2
	19.8	2.6	7.9	17.5	34.9	82.7

Table 71: Paper, Printing and Stationery, Pattern of Energy Use, 1980

(2) Printing and Publishing

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	4.6	0.1	6.9	3.4	15.0
Losses in distribution	(0.1)	-	(0.2)	-	(0.3)
Net energy supplied	4.5	0.1	6.7	3.4	14.7
Process Energy					
Via central steam/water systems 80-120°C	0.2	-	0.2	-	0.4
Via direct-process plant < 200°C	0.1	-	0.1	0.2	0.4
Stationary motive power	-	-	-	2.0	2.0
Space and Water Heating					
Via central steam/water systems	2.2	0.1	3.1	-	5.4
Via local boiler plant	0.4	-	0.4	-	0.8
Via direct-acting plant	1.6	-	2.4	0.4	4.4
Lighting/appliances	-	-	0.5	0.7	1.2
Off-road Vehicles	-	-	-	0.1	0.1
	4.5	0.1	6.7	3.4	14.7

2.6.6 Bricks, Tiles, Fireclay and Other Building Materials

105. The Digest of UK Energy Statistics 1982 estimates that this sector used some 48.0 PJ of conventional, recorded fuels/energy carriers in 1980, equivalent to some 3% of industrial energy consumption (excluding the iron and steel industry).

106. Estimates of the total fuels/energy carriers consumed by each subsector in 1980 are shown in Table 72 and Figure 20. The split by fuel/energy carrier of aggregate energy consumption is shown in Table 73 and Figure 21.

107. Energy use in the bricks and refractories industries is dominated by the kilning process: kilns are operated at very high temperatures (1,000°-1,500° C) and thus have large energy demands. Some 90% of all energy consumed in the two industries is used for kilning and drying - much of the waste heat from kilns is recovered for drying purposes but supplementary conventional fuels bought in for drying amounted to 1.9 PJ in the two industries combined.

108. Space heating and lighting made only very small demands on energy consumption (4% of total energy used) with the remaining energy used being electrical energy for materials preparation and shaping.

109. Energy use in the other building materials subsector is surprisingly large at an estimated 22.2 PJ in 1980. Asbestos products are only a minor user of energy (0.9 PJ) with about 0.5 PJ of this being used for drying and curing operations.

110. Energy use in the subsectors making up 'other building materials' is not well-defined but the British Ceramic Manufacturers Research Association estimates that about 50% of all energy used in the building products and abrasives industries was for space heating purposes. The firing and calcining of products used an estimated 20% of energy supplied, with lower temperature processes, e.g. curing of concrete and cement products using another estimated 15%.

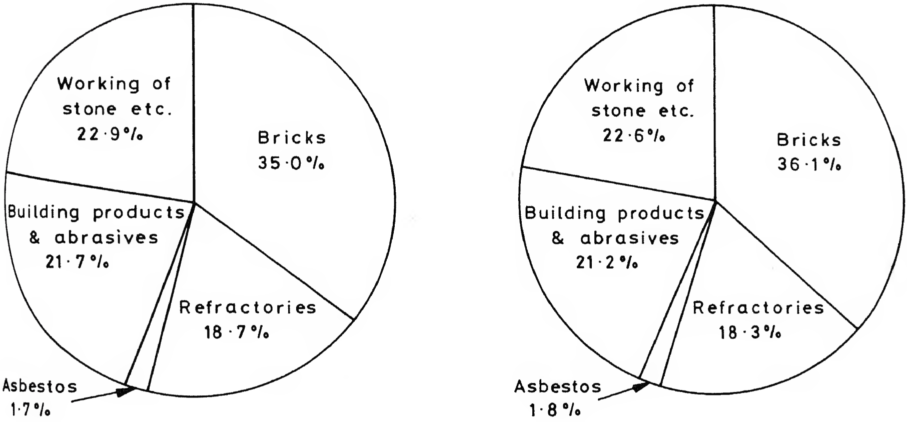
111. Much of the energy supplied to the working of stone etc. subsector is used in the melting of bitumen for coated products: an estimated 6 to 7 PJ was used in this way with the remaining energy used for similar processes as in the building products and abrasives industries and for electrical motive power, space heating and lighting.

112. Tables 74 to 77 show full details of energy use in the sector for 1980.

Table 72. Energy use in bricks etc, split by subsector, 1980

PJ	Delivered Energy	Primary Fuel Equivalent
Bricks	16.8	19.9
Refractories	9.0	10.1
Asbestos goods	0.8	1.0
Building products & abrasives	10.4	11.7
Working of stone & other non-metallic minerals	11.0	12.4
	48.0	55.1

Figure 20. Energy use in bricks etc, split by subsector, 1980



Delivered Energy

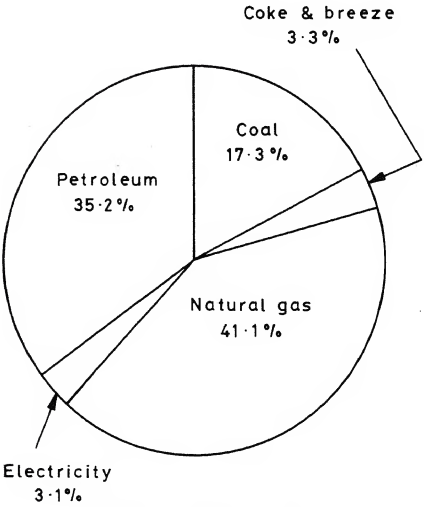
Primary Fuel Equivalent

2.6.6 Bricks, etc.

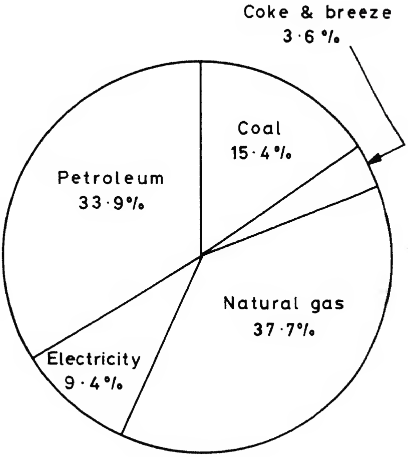
Table 73. Energy use in bricks, tiles, fireclay and other building materials split by fuel/energy carrier, 1980

PJ	Delivered Energy	Primary Fuel Equivalent
Coal	8.3	8.5
Coke and breeze	1.6	2.0
Natural gas	19.7	20.8
Electricity	1.5	5.2
Petroleum	16.9	18.6
	48.0	55.1

Figure 21. Energy use in bricks, tiles, fireclay and other building materials split by fuel/energy carrier, 1980



Delivered Energy



Primary Fuel Equivalent

Table 74: Bricks, Tiles, Fireclay and Other Building Materials, Pattern of Energy Use, 1980

	PJ - Delivered Energy				
	Liquids	Solids	Gases*	Electricity	Total
Gross energy supplied	16.9	9.9	20.7	1.8	49.3
Losses in distribution	(0.2)	(0.1)	(0.2)	-	(0.5)
Net energy supplied	16.7	9.8	20.5	1.8	48.8
(a) Process Energy					
Via central steam/water systems					
< 80°C	0.3	0.2	0.4	-	0.9
80-120°C	0.8	0.5	1.4	-	2.7
Via direct-process plant					
< 200°C	1.1	0.6	1.8	-	3.5
> 400°C	10.8	7.0	12.5	-	30.3
Stationary motive power	-	-	-	1.0	1.0
(b) Space and Water Heating					
Via central steam/water systems	1.5	0.9	1.2	-	3.6
Via local boiler plant	0.5	0.6	0.6	-	1.7
Via direct-acting plant	0.9	-	2.4	0.1	3.4
(c) Lighting/Appliances	-	-	0.2	0.4	0.6
(d) Off-road Vehicles	0.8	-	-	0.3	1.1
	16.7	9.9	20.5	1.8	48.8
Primary Fuel Equivalent of Gross Energy Supplied	18.6	10.5	20.8	5.2#	55.1

* Includes 1.0 PJ mine drainage gas.

# Excluding electricity for off-road vehicles.

2.6.6. Bricks, etc.

Table 75: Bricks, Tiles, Fireclay and Other Building Materials, Pattern of Energy Use, 1980

(1) Bricks Industry

	PJ - Delivered Energy				
	Liquids	Solids	Gases*	Electricity	Total
Gross energy supplied	6.2	3.8	7.4	0.5	17.9
Net energy supplied	6.2	3.8	7.4	0.5	17.9
Process Energy					
Via direct-process plant					
< 200°C	0.5	0.3	0.5	-	1.3
> 400°C	5.6	3.5	6.7	-	15.8
Stationary motive power	-	-	-	0.2	0.2
Space and Water Heating					
Via direct-acting plant	-	-	0.1	0.1	0.2
Lighting/appliances	-	-	0.1	0.1	0.2
Off-road Vehicles	0.1	-	-	0.1	0.2
	6.2	3.8	7.4	0.5	17.9

* Includes 1.0 PJ mine drainage gas.

Table 76: Bricks, Tiles, Fireclay and Other Building Materials, Pattern of Energy Use, 1980

(2) Refractories

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	2.6	2.5	3.7	0.2	9.0
Net energy supplied	2.6	2.5	3.7	0.6	9.4
Process Energy					
Via direct-process plant					
< 200°C	0.1	0.1	0.3	-	0.5
> 400°C	2.4	2.4	3.2	-	8.0
Stationary motive power	-	-	-	0.1	0.1
Space and Water Heating					
Via local boiler plant	-	-	0.1	-	0.1
Via direct-acting plant	0.1	-	0.1	-	0.2
Lighting/appliances	-	-	-	0.1	0.1
	2.6	2.5	3.7	0.2	9.0

Table 77: Bricks, Tiles, Fireclay and Other Building Materials, Pattern of Energy Use, 1980

(3) Other Building Materials

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	8.1	3.6	9.6	1.1	22.4
Losses in distribution	(0.2)	(0.1)	(0.2)	-	(0.5)
Net energy supplied	7.9	3.5	9.4	1.1	21.9
Process Energy					
Via central steam/water systems					
< 80°C	0.3	0.2	0.4	-	0.9
80-120°C	0.8	0.5	1.4	-	2.7
Via direct-process plant					
< 200°C	0.5	0.2	1.0	-	1.7
> 400°C	2.8	1.1	2.6	-	6.5
Stationary motive power	-	-	-	0.7	0.7
Space and Water Heating					
Via central steam/water systems	1.5	0.9	1.2	-	3.6
Via local boiler plant	0.5	0.6	0.5	-	1.6
Via direct-acting plant	0.8	-	2.2	-	3.0
Lighting/appliances	-	-	0.1	0.2	0.3
Off-road Vehicles	0.7	-	-	0.2	0.9
	7.9	3.5	9.4	1.1	21.9

2.6.7 China, Earthenware and Glass

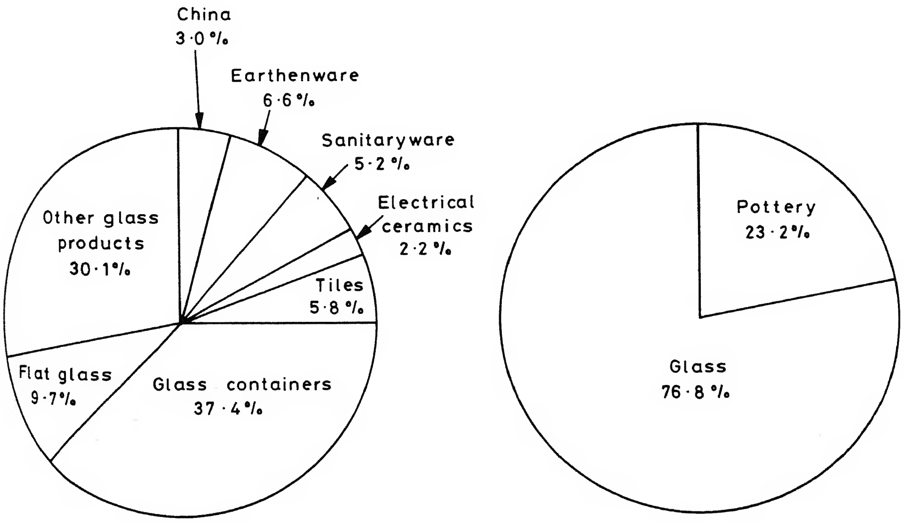
113. The Digest of UK Energy Statistics estimates that the sector used 66.8 PJ of conventional, recorded fuels/energy carriers in 1980, equivalent to 4% of total industrial energy consumption (excluding iron and steel).

114. Tables 78 and 79 and Figures 22 and 23 show total energy use split both by subsector and by fuel/energy carrier.

Table 78. Energy use in china, earthenware and glass split by subsector, 1980

PJ	Delivered Energy		Primary Fuel Equivalent
China	2.0	15.4	23.9
Earthenware	4.4		
Sanitaryware	3.5		
Electrical ceramics	1.5		
Tiles	4.0		
Glass containers	25.0	51.4	79.3
Flat glass	6.5		
Other glass products	19.9		
	66.8		103.2

Figure 22. Energy use in china, earthenware and glass, split by subsector, 1980



Delivered Energy

Primary Fuel Equivalent

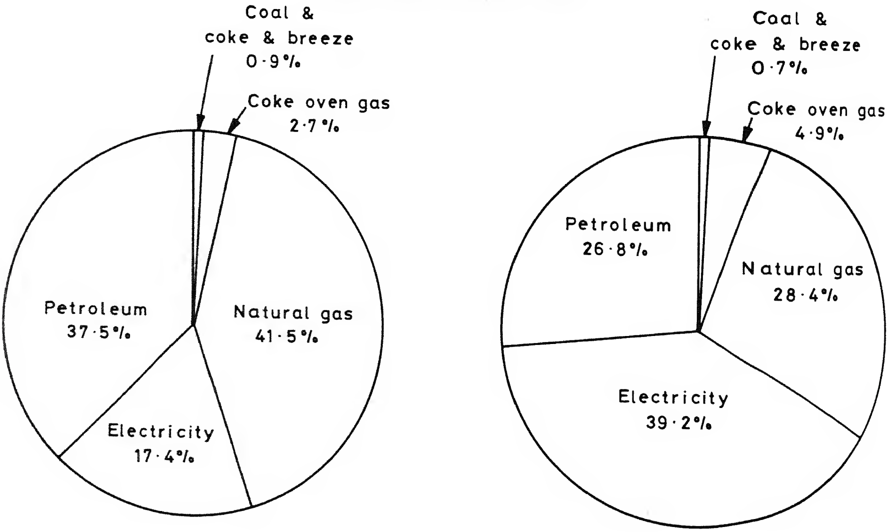
2.6.7 China, Earthenware and Glass

Table 79. Energy use in china, earthenware and glass split by fuel/ energy carrier, 1980

PJ

	Delivered Energy	Primary Fuel Equivalent
Coal	0.4	0.4
Coke and breeze	0.2	0.3
Coke oven gas	1.8	5.1
Natural gas	27.7	29.3
Electricity	11.6	40.5
Petroleum	25.1	27.6
Total	66.8	103.2

Figure 23. Energy use in china, earthenware and glass, split by fuel/ energy carrier, 1980



Delivered Energy

Primary Fuel Equivalent

115. Energy use in the pottery industry is dominated by the firing process: 58% of total energy consumed was used for this purpose in 1980. All pottery is fired at between 800 and 1250° C and usually needs more than one firing. All firing kilns are directly-fired except the muffle tunnel kilns used in the production of sanitaryware.

116. Drying and space heating consumed an estimated 27% of total energy in 1980, i.e. some 4.1 PJ. Although it is difficult to separate energy used for drying from that used for space heating as there is very little sub-metering of fuels used for purposes other than firing, the British Ceramic Research Association estimate that the amount of energy used for drying was about three times as much as that used for space heating.

117. Energy use in the glass industry is similar in nature to that of the pottery industry: an estimated 80% of energy was consumed in the processes of melting and annealing.

118. Although definitive estimates of the amounts of energy used by the melting and annealing processes are not available, it is reckoned by the British Glass Industry Research Association that the two processes used between 79-87% of total energy consumed.

119. Estimates of energy used in direct-process plant are therefore as follows.

Table 80. Energy used in direct-process plant in the glass industry, 1980

	PJ (Delivered Energy)
Melting furnaces and kilns	36.0
Forehearths	1.8
Annealing lehrs	2.9
	40.7

120. Oil and natural gas were the main fuels used, although some electric melting does take place. Relatively small amounts of LPG and coke oven gas were also used in the above processes.

121. Tables 81-83 outline the pattern of energy use for the sector for 1980.

Table 81: China, Earthenware and Glass, Pattern of Energy Use, 1980

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	25.1	0.6	29.5	11.6	66.8
Losses in distribution	-	-	(0.1)	-	(0.1)
Net energy supplied	25.1	0.6	29.4	11.6	66.7
(a) Process Energy					
Via central steam/water systems 80-120°C	0.2	0.4	0.4	-	1.0
Via direct-process plant					
< 200°C	0.5	-	1.6	-	2.1
> 400°C	22.0	-	25.1	2.4	49.5
Stationary motive power	-	-	-	8.0	8.0
(b) Space and Water Heating					
Via central steam/water systems	1.8	0.2	1.5	-	3.5
Via local boiler plant	0.2	-	0.2	-	0.4
Via direct-acting plant	0.2	-	0.4	0.4	1.0
(c) Lighting/appliances	-	-	0.2	0.8	1.0
(d) Off-road vehicles	0.2	-	-	-	0.2
	25.1	0.6	29.4	11.6	66.7
Primary Fuel Equivalent of Gross Energy Supplied	27.6	0.7	34.4	40.5	103.2

Table 82: China, Earthenware and Glass, Pattern of Energy Use, 1980

(1) Pottery Industry

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	3.1	0.6	9.0	2.7	15.4
Losses in distribution	-	-	(0.1)	-	(0.1)
Net energy supplied	3.1	0.6	8.9	2.7	15.3
Process Energy					
Via central steam/water systems 80-120°C	0.2	0.4	0.4	-	1.0
Via direct-process plant					
< 200°C	0.5	-	1.6	-	2.1
> 400°C	2.1	-	6.3	0.4	8.8
Stationary motive power	-	-	-	2.0	2.0
Space and Water Heating					
Via central steam/water systems	0.1	0.2	0.1	-	0.4
Via direct-acting plant	0.2	-	0.4	-	0.6
Lighting/appliances	-	-	0.1	0.3	0.4
	3.1	0.6	8.9	2.7	15.3

2.6.7. China, Earthenware and Glass

Table 83: China, Earthenware and Glass, Pattern of Energy Use, 1980

(2) Glass Industry

	PJ - Delivered Energy			
	Liquids	Gases	Electricity	Total
Gross energy supplied	22.0	20.5	8.9	51.4
Net energy supplied	22.0	20.5	8.9	51.4
Process Energy				
Via direct-process plant > 400°C	19.9	18.8	2.0	40.7
Stationary motive power	-	-	6.0	6.0
Space and Water Heating				
Via central steam/water systems	1.7	1.4	-	3.1
Via local boiler plant	0.2	0.2	-	0.4
Via direct-acting plant	-	-	0.4	0.4
Lighting/appliances	-	0.1	0.5	0.6
Off-road vehicles	0.2	-	-	0.2
	22.0	20.5	8.9	51.4

2.6.8 Cement

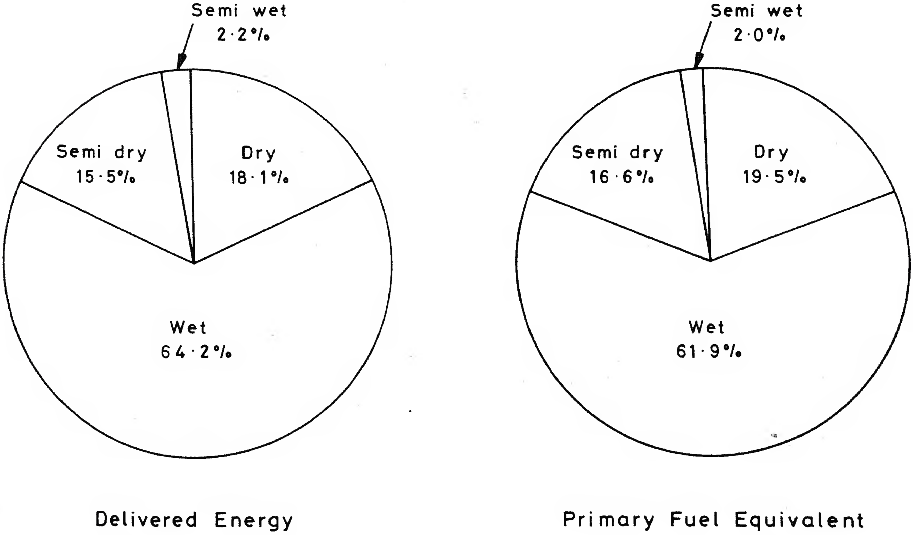
122. The cement industry used 83.0 PJ of conventional, recorded fuels/ energy carriers in 1980, equivalent to 5% of consumption by the other industry sector.

123. Cement is manufactured by four different processing routes, ranging from 'wet' to 'dry', with each route consuming differing average amounts of energy, according to the way materials are dealt with up to the calcining stage. Table 84 and Figure 24 show the proportions of the industry's total energy consumption attributable to each of the four processing routes. In addition, Table 85 and Figure 25 show the industry's total energy consumption split by fuel/ energy carrier.

Table 84. Total energy consumption of the cement industry split by manufacturing process, 1980

	PJ Delivered Energy	 Primary Fuel Equivalent
Dry process	15.0	19.5
Wet process	53.3	61.9
Semi dry process	12.9	16.6
Semi wet process	1.8	2.0
	83.0	100.0

Figure 24. Proportions of fuels/ energy carriers used by the cement manufacturing processes in 1980

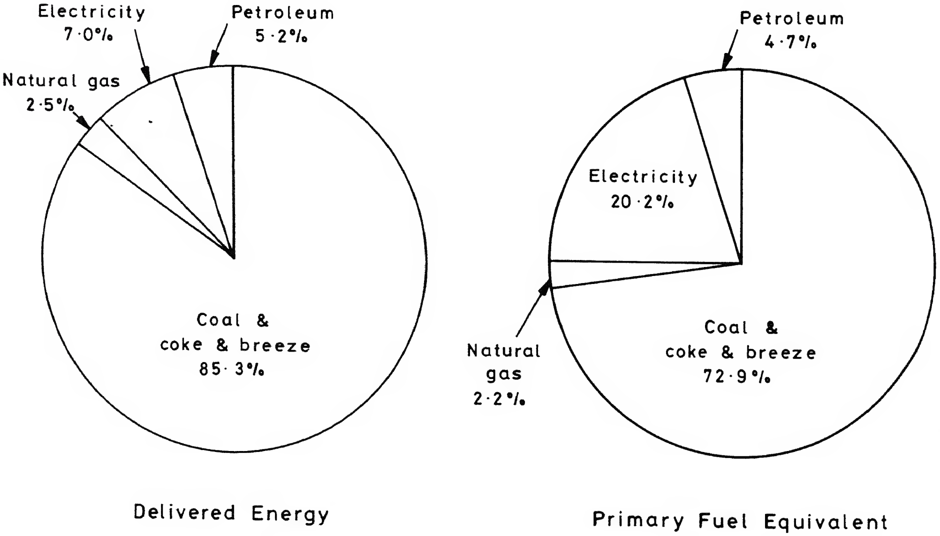


2.6.8 Cement

Table 85. Total energy used by the cement industry in 1980, split by fuel/ energy carrier

	PJ Delivered Energy	Primary Fuel Equivalent
Coal	70.7	72.8
Coke and breeze	0.1	0.1
Natural gas	2.1	2.2
Electricity	5.8	20.2
Petroleum	4.3	4.7
	83.0	100.0

Figure 25. Total energy consumed by the cement industry split by fuel/ energy carrier 1980



124. Energy use in the cement industry is dominated by the drying and calcining processes - about 80% of total energy used (67.5 PJ) was used in the firing of kilns for the production of clinker, a compound of calcium silicates, aluminate and aluminoferrite. A small amount of oil, 0.2 PJ, was used in the actual firing process in 1980 with the remaining kilns being coal-fired. Oil and gas were used for drying of raw materials and for space

and water heating. In addition 5.8 PJ of electricity was used by the industry in 1980, mostly in the processes of grinding the raw materials and clinker.

125. Table 86 outlines the details of the pattern of energy use of the cement industry in 1980.

Table 86: The Cement Industry, Pattern of Energy Use, 1980

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	4.3	70.8	2.1	5.9	83.1
Net energy supplied	4.3	70.8	2.1	5.9	83.1
(a) Process Energy					
Via direct-process plant					
< 200°C	3.3	3.5	1.7	–	8.5
> 400°C	0.2	67.3	–	–	67.5
Stationary motive power	–	–	–	4.4	4.4
(b) Space and Water Heating					
Via local boiler plant	0.2	–	0.1	–	0.3
Via direct-acting plant	0.5	–	0.3	1.0	1.8
(c) Lighting/appliances	–	–	–	0.4	0.4
(d) Off-road vehicles	0.1	–	–	0.1	0.2
	4.3	70.8	2.1	5.9	83.1
Primary Fuel Equivalent of Gross Energy Supplied	4.7	72.9	2.2	20.2#	100.0

# Excluding electricity used for off-road vehicles

2.6.9 Chemicals and Allied Trades

126. The chemicals and allied trades sector used 435.8 PJ of conventional, recorded fuels/energy carriers in 1980, equivalent to 25% of other industry's total energy consumption. If petroleum feedstocks are included as part of the industry's energy use, this figure rises to 603.6 PJ.

127. Petroleum feedstocks were made up of 85% naphtha (light distillate feedstock), with the remainder being LPG and other products, including liquid natural gas. These feedstocks can be distinguished from the petroleum products used for energy purposes in the sector: those products used as feedstocks are chemically and physically distinct from those used as fuels and are bought, transported and stored as separate products. These feedstocks are accounted for separately in the UK Digest of Energy Statistics and are not included as an energy input to the chemicals and allied trades sector.

128. Natural gas feedstock is, on the contrary, identical to that used as fuel, so that any separate accounting depends on metering the flows to individual plants. This is a somewhat arbitrary method of estimation, given the highly integrated nature of much chemical plant, so the UK Digest does not attempt to distinguish between the two uses of natural gas supplied to the sector. Natural gas feedstock is, however, used almost exclusively for the production of ammonia and methanol and the amount of gas used as feedstock has been estimated as being equivalent to that supplied to ammonia and methanol plants, i.e. 113.2 PJ.

129. As mentioned in paragraph 127, most chemical plant is highly integrated in nature with a single site usually able to produce a wide variety of end products. Among the larger companies which produce the basic organic and inorganic chemicals in bulk as well as the downstream products such as paints and pesticides, several plants making products which are classified into different industry subsectors may be grouped on one site, often sharing common energy supplies.

130. Very often heat is 'cascaded' from one plant for use in others and waste heat and heat from raw materials in exothermic reactions in one plant are often used as energy inputs to adjacent ones. This makes it difficult to determine an actual pattern of energy use for each of the nine major product groupings of the sector.

131. The total energy used by each of these product groupings, using various sources, are shown in Table 87 and Figure 26 together with total energy use in the sector split by product. Petroleum feedstocks are not included in the analysis, to conform with the Digest. In addition, Table 88 and Figure 27 show total energy use, split by individual fuel/energy carrier.

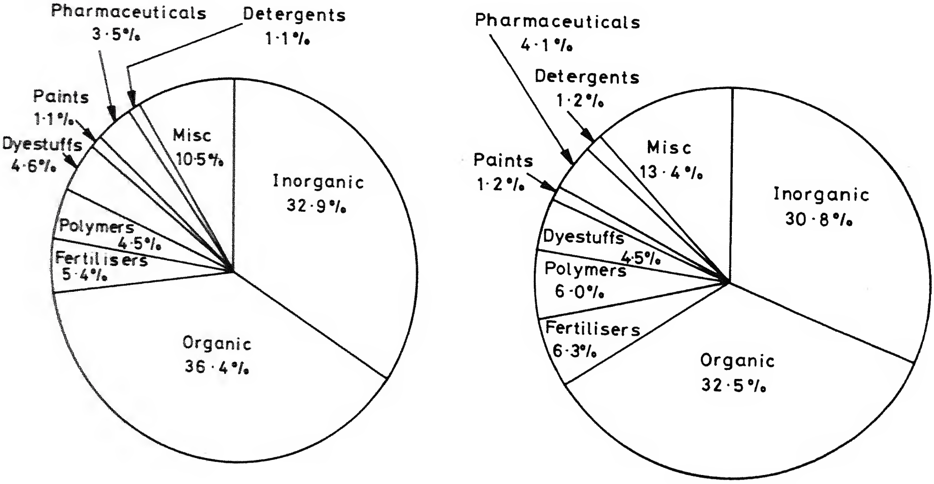
132. CHP schemes and self-generation accounted for large amounts of energy used in the sector. Some 18.2 PJ of electricity were generated in 1980, equivalent to 28% of the sector's total electricity requirements. In addition, CHP schemes produced an etimated 106.4 PJ of steam, mainly for process use. In total, 162.0 PJ of conventional fuels were consumed by private generation and CHP schemes, at a total fuel efficiency of 77%.

2.6.9 Chemicals and Allied Trades

Table 87. Total energy used in chemicals and allied trades, 1980 split by product

		PJ
	Delivered Energy	Primary Fuel Equivalent
Inorganic chemicals	143.4	181.2
Organic chemicals	158.8	191.2
Fertilisers	23.5	36.9
Polymers	19.7	35.5
Dyestuffs	19.9	26.7
Paints	4.6	6.9
Pharmaceuticals	15.3	24.1
Detergents	4.7	7.0
Miscellaneous	45.9	78.5
	435.8	588.0

Figure 26. Total energy used in chemicals and allied trades, 1980 split by product



Delivered Energy

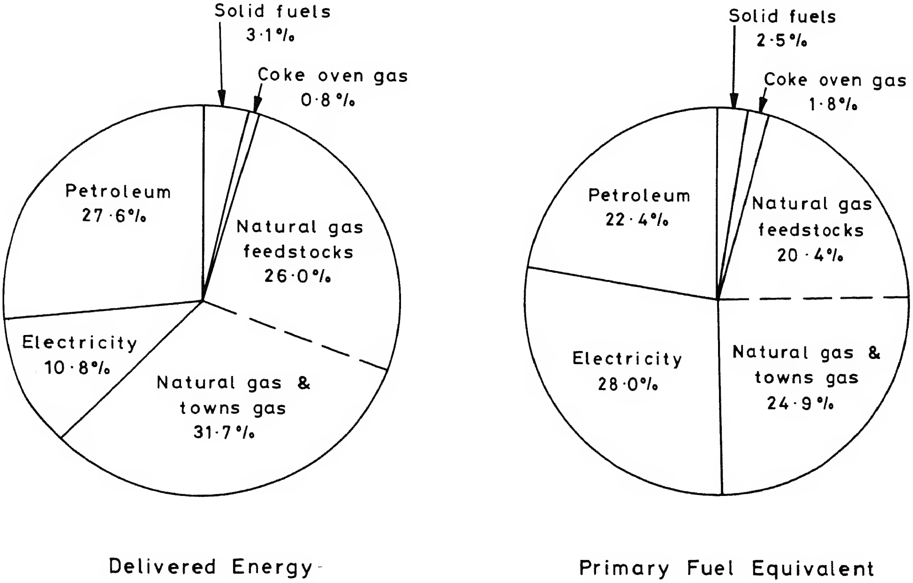
Primary Fuel Equivalent

Table 88. Total energy used* in chemicals and allied trades, 1980 split by fuel/energy carrier

	PJ Delivered Energy	Primary Fuel Equivalent
Coal	10.3	10.6
Coke and breeze	2.4	3.0
Coke oven gas	3.7	10.5
Towns gas	0.1	0.2
Natural gas	251.4	266.2
Electricity	47.2	164.8
Petroleum	119.9	131.7
Creosote/pitch	0.8	1.0
	435.8	588.0

* In addition, it is estimated that waste heat and heat from raw materials contributed a further 100 PJ of energy used in the sector, principally in the organic chemicals subsector.

Figure 27. Total energy used in chemicals and allied trades, 1980 split by fuel/energy carrier



2.6.9 Chemicals and Allied Trades

133. Process heat amounted to 189.2 PJ, most of this (some 71%) being provided as steam by boiler systems. This process energy is applied in a variety of ways on chemical plant as mentioned in paragraph 129. High temperature processes include ore reduction and the calcining of minerals, usually in kilns or furnaces. Electrochemical processes used 17.9 PJ of electricity in 1980, but most of the electricity demanded was for motive power of one form or another, notably for compressors and pumps. Space and water heating requirements amounted to some 7% of net energy supplied to the sector (19.0 PJ), a low figure relative to other industries.

134. Table 89 provides a full breakdown of the pattern of energy use in the sector for 1980.

Table 89: The Chemicals and Allied Trades Sector, Pattern of Energy Use, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	287.7	13.5	255.2	48.1	-	604.5
Feedstocks	(167.8)	-	(113.2)	-	-	(281.0)
Private generation/CHP	(94.2)	(11.3)	(56.5)	18.2	106.4	(37.4)
Sales to public supply/others	-	-	-	(1.9)	(1.4)	(3.3)
Losses in distribution	(1.3)	(0.1)	(4.3)	-	(5.2)	(10.9)
Net energy supplied	24.4	2.1	81.2	64.4	99.8	271.9
(a) Process Energy						
Via central steam/water systems						
< 80°C	1.5	0.2	4.1	-	11.5	16.8
80-120°C	3.5	1.0	15.6	-	43.1	63.2
> 120°C	3.1	0.8	13.3	-	37.0	54.2
Via direct-process plant						
< 200°C	2.1	-	6.9	-	-	9.0
200-400°C	7.1	-	23.5	0.6	-	31.2
> 400°C	2.9	-	9.7	2.2	-	14.8
Electrochemical	-	-	-	17.9	-	17.9
Stationary motive power	1.1	-	-	36.4	-	37.5
(b) Space and Water Heating						
Via central steam/water systems	1.6	0.1	5.5	-	-	7.2
Via local boiler plant	0.5	-	1.9	-	-	2.4
Via direct-acting plant	-	-	-	1.2	8.2	9.4
(c) Lighting/Appliances	-	-	0.7	5.2	-	5.9
(d) Off-road Vehicles	1.5	-	-	0.9	-	2.4
	24.4	2.1	81.2	64.4	99.8	271.9
Primary Fuel Equivalent of Gross Energy Supplied	131.7*	14.6	276.9	164.8#	-	588.0

* Less feedstocks, as in the UK Digest of Energy Statistics

# Excluding electricity used for off-road vehicles

2.6.10 Other Trades

2.6.10 Other Trades

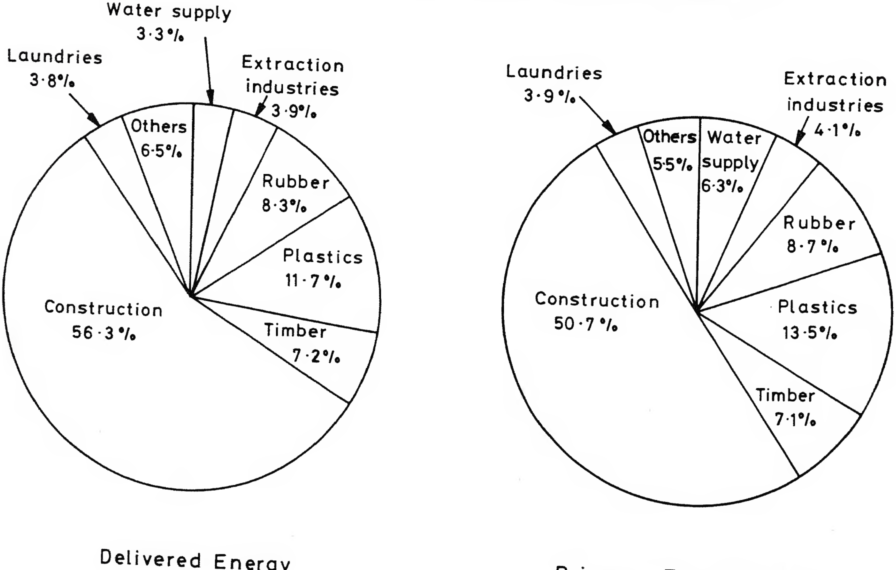
135. The other trades sector used 277.0 PJ of fuels/energy carriers in 1980, equivalent to 16% of total energy used in the industry (excluding the iron and steel industry).

136. An energy use split has been estimated from information contained in Thrift Scheme Reports, Business Statistics Office data and ETSU Report R7. Tables 90 and 91 and Figures 28 and 29 therefore show total sectoral energy use split by industrial subsector and by fuel/energy carrier.

Table 90. Energy use in other trades, split by industry, 1980

		PJ
	Delivered Energy	Primary Fuel Equivalent
Water supply	9.2	26.1
Extraction industries, (i.e. mining/quarrying)	10.7	16.7
Rubber manufacture	23.0	36.5
Plastics manufacture	32.4	55.7
Timber, furniture etc.	17.3	29.4
Construction	156.0	208.5
Laundries	10.5	16.0
Other manufacturers	17.9	22.5
	277.0	411.4

Figure 28. Energy use in other trades, split by industry, 1980



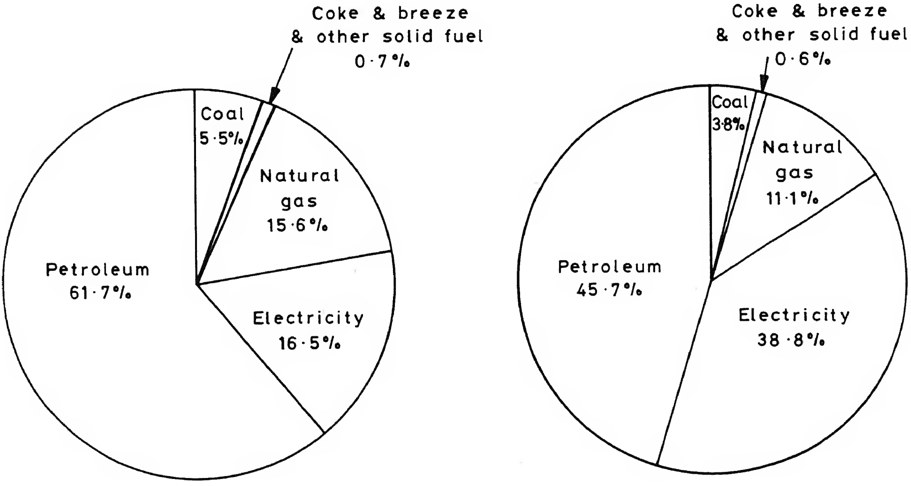
Delivered Energy

Primary Fuel Equivalent

Table 91. Energy use in other trades, split by fuel/energy carrier

	PJ	
	Delivered Energy	Primary Fuel Equivalent
Coal	15.2	15.6
Coke and breeze	0.6	0.8
Other solid fuel	1.3	1.7
Natural gas	43.2	45.7
Electricity	45.7	159.6
Petroleum	171.0	188.0
	277.0	411.4

Figure 29. Energy use in other trades, split by fuel/energy carrier, 1980



Delivered Energy

Primary Fuel Equivalent

137. As Table 90 shows, the construction industry dominates energy use (and indeed production) in the other trades sector. The paucity of detailed information on energy use in the construction industry unfortunately precludes a very detailed assessment of the pattern of energy use but it can be inferred that the industry does, indeed, have a wide range of end-uses. It is a heavy user of oils for off-road vehicles and for motive power - two minor uses of oil in other industries - and has a larger than average space and water heating component, i.e. about 25% of total energy used.

2.6.10 Other Trades

138. Other heavy users of energy in the other trades sector include rubber and plastics manufacturing and the timber and furniture industry. These industries together consumed 72.7 PJ in 1980.

139. Rubber and plastics manufacturing requires large amounts of energy for vulcanisation and other heat treatment and this is mostly provided through boiler systems: some 68% of all energy used in the two industries together is passed through boilers. These two industries also have a large electricity requirement, mostly for motive power in the forming and extrusion processes.

140. The timber and furniture industries use most of their energy for space and water heating - some 68% of all energy used in 1980 was for this purpose, mostly provided by direct-acting plant. The only process of note in the industry is the drying of timber in kilns, which consumed 1.7 PJ in total in 1980. Wood waste is used extensively through the industry and can provide as much as 20% of an individual premises energy requirements.

141. Tables 92 to 95 provide a detailed breakdown of estimated energy use in the other trades sector for 1980.

Table 92: Other Trades, Pattern of Energy Use, 1980

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	171.0	17.1	43.2	46.2	-	277.5
Private generation/CHP	(3.2)	-	(8.8)	1.2	7.3	(3.5)
Sales to public supply/others	-	-	-	(0.5)	-	(0.5)
Losses in distribution	(3.5)	(0.7)	(1.2)	-	(0.5)	(6.1)
Net energy supplied	164.3	16.4	33.2	46.9	6.8	267.6
(a) Process Energy						
Via central steam/water systems						
< 80°C	0.7	0.4	0.8	-	0.7	2.6
80-120°C	19.1	1.9	2.3	-	2.0	25.3
> 120°C	30.7	3.9	10.2	-	-	44.8
Via direct-process plant						
< 200°C	5.6	-	1.6	0.8	-	8.0
200-400°C	7.4	-	2.4	0.7	-	10.5
> 400°C	12.5	2.9	1.4	0.3	-	17.1
Stationary motive power	11.5	-	-	38.0	-	49.5
(b) Space and Water Heating						
Via central steam/water systems	16.4	3.4	8.1	-	-	27.9
Via local boiler plant	20.6	3.9	0.9	-	-	25.4
Via direct-acting plant	13.1	-	3.6	3.2	4.1	24.0
(c) Lighting/Appliances	-	-	1.9	3.4	-	5.3
(d) Off-road Vehicles	26.7	-	-	0.5	-	27.2
	164.3	16.4	33.2	46.9	6.8	267.6
Primary Fuel Equivalent of Gross Energy Supplied	188.0	18.1	45.7	159.6#	-	411.4

Excluding electricity used by off-road vehicles

2.6.10 Other Trades

Table 93: Other Trades, Pattern of Energy Use, 1980

(1) Rubber and Plastics Manufacture

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total
Gross energy supplied	17.6	4.1	20.2	13.5	55.4
Losses in distribution	(0.7)	(0.3)	(0.8)	-	(1.8)
Net energy supplied	16.9	3.8	19.4	13.5	53.6
Process Energy					
Via central steam/water systems					
< 80°C	0.3	0.2	0.6	-	1.1
80-120°C	1.1	0.5	1.4	-	3.0
> 120°C	7.7	2.1	8.5	-	18.3
Via direct-process plant					
< 200°C	0.5	-	0.7	0.4	1.6
Stationary motive power	0.4	-	-	11.7	12.1
Space and Water Heating					
Via central steam/water systems	5.8	1.0	6.5	-	13.3
Via direct-acting plant	1.1	-	1.3	0.6	3.0
Lighting/Appliances	-	-	0.4	0.8	1.2
	16.9	3.8	19.4	13.5	53.6

Table 94: Other Trades, Pattern of Energy Use, 1980

(2) Timber, Furniture etc

	PJ - Delivered Energy				
	Liquids	Solids	Gases	Electricity	Total*
Gross energy supplied	8.6	1.1	3.2	4.6	17.5
Losses in distribution	(0.2)	(0.1)	-	-	(0.3)
Net energy supplied	8.4	1.0	3.2	4.6	17.2
Process Energy					
Via central steam/water systems 80-120°C	1.0	0.2	0.2	-	1.4
Via direct-process plant < 200°C	0.2	-	0.1	-	0.3
Stationary motive power	-	-	-	2.9	2.9
Space and Water Heating					
Via central steam/water systems	2.2	0.8	0.8	-	3.8
Via local boiler plant	0.7	-	0.5	-	1.2
Via direct-acting plant	4.3	-	1.3	1.3	6.9
Lighting/appliances	-	-	0.3	0.2	0.5
Off-road vehicles	-	-	-	0.2	0.2
	8.4	1.0	3.2	4.6	17.2

* In addition, it is estimated that 2.5 PJ of wood waste was used for energy purposes

2.6.10 Other Trades

Table 95: Other Trades, Pattern of Energy Use, 1980

(3) Construction and Other Industries

	PJ - Delivered Energy					
	Liquids	Solids	Gases	Electricity	Steam	Total
Gross energy supplied	144.8	11.9	19.8	28.1	-	204.6
Private generation/CHP	(3.2)	-	(8.8)	1.2	7.3	(3.5)
Sales to public supply	-	-	-	(0.5)	-	(0.5)
Losses in distribution	(2.6)	(0.3)	(0.4)	-	(0.5)	(3.8)
Net energy supplied	139.0	11.6	10.6	28.8	6.8	196.8
Process Energy						
Via central steam/water systems						
< 80°C	0.4	0.2	0.2	-	0.7	1.5
80-120°C	17.0	1.2	0.7	-	2.0	20.9
> 120°C	23.0	1.8	1.7	-	-	26.5
Via direct-process plant						
< 200°C	4.9	-	0.8	0.4	-	6.1
200-400°C	7.4	-	2.4	0.7	-	10.5
> 400°C	12.5	2.9	1.4	0.3	-	17.1
Stationary motive power	11.1	-	-	23.4	-	34.5
Space and Water Heating						
Via central steam/water systems	8.4	1.6	0.8	-	-	10.8
Via local boiler plant	19.9	3.9	0.4	-	-	24.2
Via direct-acting plant	7.7	-	1.0	1.3	4.1	14.1
Lighting/appliances	-	-	1.2	2.4	-	3.6
Off-road vehicles	26.7	-	-	0.3	-	27.0
	139.0	11.6	10.6	28.8	6.8	196.8

2.7 TRANSPORT

142. The transport sector accounted for 1488.6 PJ of fuels/energy carriers in 1980, equivalent to 25% of total UK energy consumption. Petroleum products accounted for 99% of total energy use in the sector.

143. Road transport constituted by far the largest user of fuels (1165.0 PJ) with motor spirit the main fuel used. A large amount of Derv (266.8 PJ) was also used, mostly by goods vehicles but cars and motorcycles consumed 67% of fuels used by road vehicles.

144. Other transport, i.e. rail, air and water, consumed large amounts of liquid fuels, 310.7 PJ in total. Of this 310.7 PJ, 86.0 PJ of gas/diesel oil was used by railways and water transport with 219.6 PJ of aviation fuel and 5.1 PJ of fuel oil for railways and water transport (excluding international shipping) making up the remainder of the petroleum consumption in the sector.

145. Railways consumed 11.0 PJ of electricity and 38.5 PJ of fuel- and gas/diesel oil together with a smaller amount of coal, coke and breeze and other solid fuels (1.7 PJ). In addition, it is estimated that London Transport used 8.3 PJ of gas and fuel oil to generate 2.5 PJ of electricity which is equivalent to 23% of railways' electricity requirements.

146. Marine bunkers, which accounted for 107.3 PJ of fuels, are included in this analysis. Tables 96 and 97 and Figures 30 and 31 show the transport sector's full pattern of energy use.

2.7 Transport

Table 96. Energy Use in the Transport Sector, 1980

	PJ - Delivered Energy				
	Liquids	Gases	Solids	Electricity	Total
Gross energy supplied	1583.7	7.6	1.9	9.4	1602.6
Private generation	(0.7)	(7.6)	-	2.5	(5.8)
Marine bunkers	(107.3)	-	-	-	(107.3)
Sales to public supply/ others	-	-	-	(0.9)	(0.9)
Net energy supplied	1475.7	-	1.9	11.0	1488.6
Mode					
Road transport	1165.0	-	-	-	1165.0
Railways	38.5	-	1.7	11.0	51.2
Water transport	52.6	-	0.2	-	52.8
Air transport	219.6	-	-	-	219.6
	1475.7	-	1.9	11.0	1488.6

Table 97. Consumption of Liquid Fuels in the Transport Sector, Split by Transport Mode, 1980

	PJ - Delivered Energy				
	Motor Spirit	Gas/ Diesel Oil	Fuel Oil	Aviation Fuels	Total
Cars/ motorcycles	764.3	-	-	-	764.3
PSV and taxis	3.7	39.1	-	-	42.8
Goods vehicles	120.7	221.4	-	-	342.1
Other vehicles	10.3	5.5	-	-	15.8
Railways	-	36.8	1.7	-	38.5
Water transport*	-	49.2	3.4	-	52.6
Air transport	-	-	-	219.6	219.6
	899.0	352.0	5.1	219.6	1475.7

* In addition, marine bunkers accounted for 107.3 PJ of liquid fuels, made up of 72.8 PJ fuel oil, 34.5 PJ gas oil and marine diesel oil.

Figure 30. Energy use in the transport sector, 1980 on net energy supplied basis, split by fuel/energy carrier

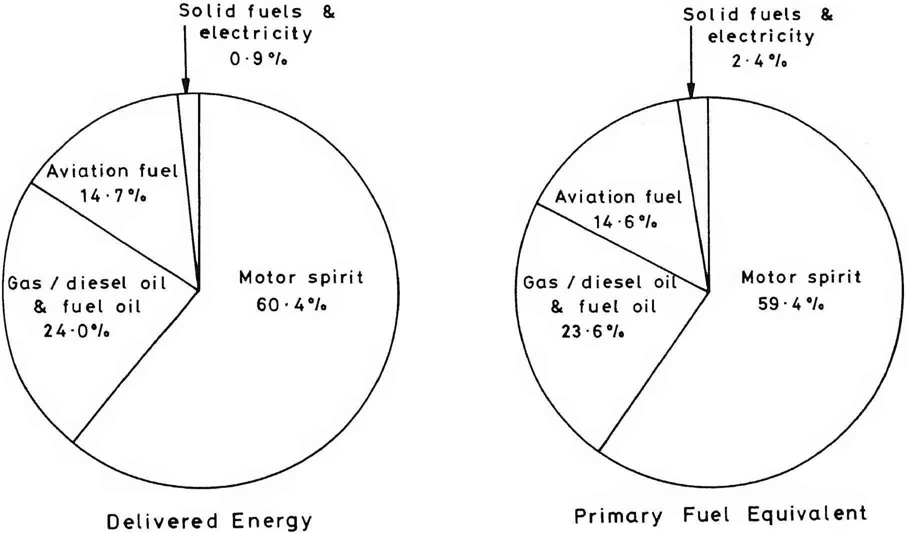
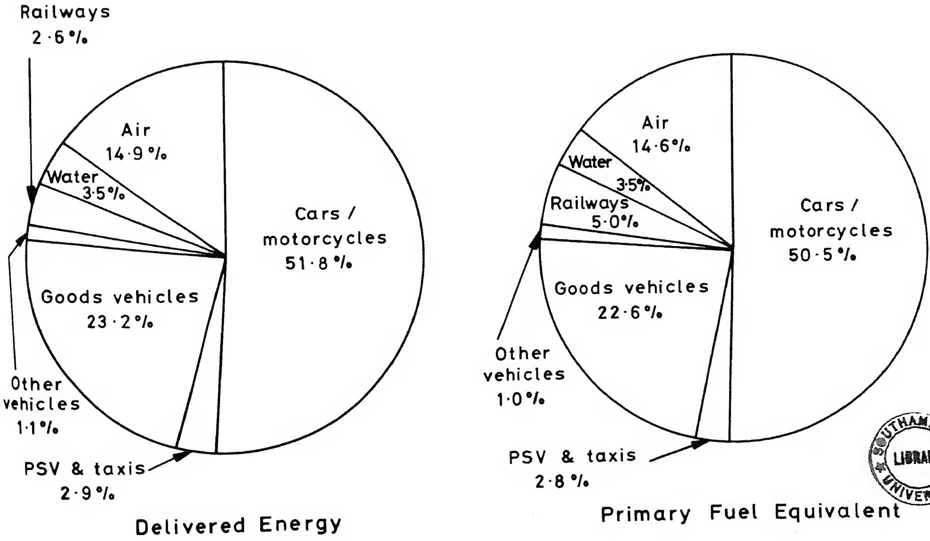


Figure 31. Energy use in the transport sector, 1980 on a net energy supplied basis, split by transport mode



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ANNEX

THE CALCULATION OF THE PRIMARY FUEL EQUIVALENT OF DELIVERED ENERGY 1980

Objectives

1. The objectives of this annex are as follows:

   (a) to present a description of the methodology of the calculation

   (b) to present an analysis of energy flows and energy-industry interactions both in tabular form and diagrammatically: the former is necessary for the calculation itself but flow-diagrams for each industry are produced for extra clarity

   (c) to present the actual Primary Fuel Equivalents of the amounts of energy used by direct consumers for 1980.

The analysis is carried out in terms of primary fuels, i.e. coal, oil, natural gas, nuclear- and hydro-electricity in order to be able to provide a comparative basis of the claims made by direct consumers of all fuel and energy-carriers on finite energy resources. We require to know with as much accuracy as possible how much primary fuel is required to produce a certain output-level for numerous reasons: the most important of these is so that the potential impact of energy-saving and fuel-switching measures can be evaluated and that, given this basis, investment in new energy technologies can be more effectively planned.

Definitions

2. The Primary Fuel Equivalent (PFE) of a certain amount of energy delivered to direct consumers can be described as the amount itself plus the quantity of energy used in the realisation of that amount.

3. Direct consumers include the following sectors: transport, domestic, public administration, agriculture, industry (including iron and steel) and other miscellaneous consumers. Direct consumption is made up of energy supplied by UK industry plus imported fuels and energy-carriers as well as any decrease in year-to-year stocks of the latter which may have taken place.

4. This is distinguished from the term 'final consumption' which includes direct consumption plus energy supplied to other fuel industries, for export and, in the case of petroleum products, to ships' bunkers, for petrochemical feedstocks and for non-energy purposes etc., as lubricants.

5. 'Handled energy' refers to final consumption (which, as stated above, includes direct consumption) plus any conversion and distribution losses incurred and an energy industry's own use of its produced fuel or energy-carrier.

6. Fuller descriptions of the constituent parts of each definition are given in this paper. Table A.1 gives the total quantities of energy ascribed to each of the above categories for each fuel and energy-carrier. These results are derived from Part I of this analysis.

Table A.1: Delivered Energy in 1980, PJ

Fuel/ Energy-Carrier	Direct Consumption	Final Consumption	Handled[a] Energy
Coal	538.4	3122.8	3140.6
Natural Gas	1738.1	1756.8	1858.8
Oil/ Petroleum Products	2615.7	3983.1	4330.7
Other Solid Fuels (OSF)	63.0	66.7[b]	89.7[c]
Towns Gas	3.3	3.3	4.4
Substitute Natural Gas	6.0	6.0	6.7
Electricity	807.3	832.1	2812.6
Coke and Breeze	166.5	234.9	281.7
Coke Oven Gas	26.9	26.9	74.5
Creosote and Pitch	1.5	1.5	1.8

a: Electricity inputs to collieries, refineries, coke ovens and towns gasworks are not included in the definition of handled energy as they are not regarded as the direct fuel input to be converted. However, electricity inputs are dealt with in part II, by ascribing them to the direct consumption of the appropriate fuels.

b: Does not include 2.8 PJ of coke and breeze arising at OSF plants.

c: 84.8 PJ (input to OSF production) + 4.9 PJ imports.

7. It is important to note that not all of the volumes of primary fuels attributed to the direct consumption of some fuels is actually used by the fuel industry concerned. For example, although no nuclear electricity is actually used directly by collieries, the direct consumption of coal is ascribed a certain amount of nuclear electricity (1.4 PJ). This is because all the primary fuel is allocated to its appropriate end-use. So, even though no direct nuclear electricity is used in the coal-extraction process, it is a direct input to the electricity supply industry, part of whose output goes to collieries. It is therefore reasonable to attribute a certain proportion of that nuclear input to the direct consumption of coal. Thus, the greater the proportion of total electricity output being used as an energy input by collieries, the greater the proportions of the fuel inputs to the electricity supply industry being allocated to the direct consumption of coal.

8. All such allocations are done on a pro-rata basis except where evidence is deemed to suggest otherwise. For example, with natural gas, since direct consumers require such an extensive distribution network it is highly likely that the vast majority of distribution losses occur in this network through leakages.

9. All distribution losses (36.8 PJ) and the use of natural gas itself in getting the gas from the North Sea to the houses and buildings of direct consumers (own use in distribution, 51.1 PJ) are accordingly allocated to direct consumption only rather than being pro-rated over direct consumption and other final consumption categories, i.e. use of natural gas in the electricity supply industry, collieries and coke ovens. The amount of gas used for space and water heating in the industry itself is labelled 'own use in production' and is allocated over final consumption categories pro-rata.

10. For the operations of coke ovens, the analysis is initially carried out on an aggregate basis, i.e. fuel inputs, conversion and distribution losses and own uses are totalled to present an overall picture of coke oven operations. However, as coke ovens produce three basic outputs, i.e. coke and breeze (classified as one output), coke oven gas and creosote and pitch (classified as one output), these losses and own use are disaggregated according to UK Digest of Energy Statistics figures and are thus allocated to the appropriate direct consumption of the fuel.

11. In assessing the claims made upon primary fuel sources by direct consumers, four destinations of fuel or energy carrier handled by an energy industry can be identified, besides the quantity eventually reaching the final consumer. These are:

(1) Use of the fuel input in the conversion process

In the case of electricity for example, only 30% of the energy in the coal burned to raise steam appears as electrical energy which actually reaches the final consumer as delivered energy.

These 70% 'conversion losses', i.e. the difference between the thermal values of inputs to and the output of an energy industry are accounted for by allocating them pro-rata over the final consumption categories of the industry concerned. Since direct consumption is by far the largest of these categories in the case of electricity, it is accordingly allocated a large proportion of these losses.

(2) Losses in distribution

Energy losses occur between the points of production and consumption, e.g. gas leakages. Such losses are, on the whole, small relative to conversion losses but are treated in the same manner, i.e. through pro-rata allocation over final consumption categories (with the exception of natural gas and coke ovens, both mentioned above).

(3) The use of the fuel produced by an industry within the industry itself (own use)

Again, these uses of energy are all allocated over final consumption categories pro-rata (with the exceptions of own use in distribution in the case of natural gas and own use in coke oven operations, both mentioned above).

(4) The use of the fuel supplied for non-conversion purposes

A relatively small amount of coal not actually used in the ovens is taken by the coke industry. This is dealt with in this paper, by including it as a conversion loss.

The Supply of Electricity to Other Energy Industries

12. Uses in other energy industries are classed as final consumption categories and so these amounts must be allocated to the direct consumption of the appropriate fuel. Part II deals with the use of electricity in other fuel industries. The relatively small amount of methane supplied to collieries is also accounted for at this stage, to present a full description of the fuel inputs to collieries. The electricity used by refineries, coke ovens and towns gasworks is also dealt with at this stage.

13. The electricity thus used is accordingly allocated pro-rata over the final consumption categories of the industry concerned. This necessarily means providing an 'input' to other receiving fuel industries, e.g. in the case of collieries, 49.8 PJ for electricity generation, which is then in a repeat allocation, or iteration, assigned (on a pro-rata basis again) to the final consumption categories of the receiving industry. A second or third iteration may be necessary until all the PFE of the initial electrical energy supply to other fuel industries has been correctly allocated to the direct consumption of the appropriate fuel.

Results

14. For all the reasons mentioned above then, the energy supplied to direct consumers by a fuel industry is less than the amount actually being handled by it. 538.4 PJ of coal are used by direct consumers whereas the industry handles a total of 3140.6 PJ. As far as electricity generation is concerned,

conversion losses constitute the largest single destination of handled energy, exceeding direct consumption by a ratio of approximately 2.4:1.

15. With primary fuel industries (coal, natural gas) and petroleum products, however, it is own use which accounts for the major part of the divergence between final consumption and handled energy.

16. Conversion losses constitute the major part of the difference between final consumption and handled energy for coke and breeze, with own use responsible for the divergence in the case of coke oven gas.

International Trade and Stock Changes

17. The analysis must take place within the context of international trade in fuels and energy carriers and where changes in stocks of the latter are constantly taking place. These dynamic phenomena are dealt with by comparing one end-year level of the above with another and so estimating an aggregate change over the year in question.

18. An import of a fuel constitutes an addition to consumption in this country as does a decrease in the level of held stocks (this usually comes about through producers not anticipating the state of the market and under-producing, i.e. a shortfall in supply to meet a given level of demand or through not foreseeing an excess demand and producing a similar level of supply to the previous year). Imports and stock decreases of secondary fuels are included in the definition of direct consumption but the split between domestically produced and imported energy is shown where appropriate. This split is based on the following propositions: that all imports are spread evenly (pro-rata) over all final consumption categories, that the ratio of PFE to delivered energy for imported energy is the same as for domestically produced energy and that all exports of energy do, in fact, come out of domestic production.

19. Exports and increases in stocks are regarded as final consumption categories and grouped together (where both occur in a particular energy industry). International trade and stock changes in primary fuels (coal, natural gas, and crude oil), are already included in the figures provided for those industries by the UK Digest of Energy Statistics 1981.

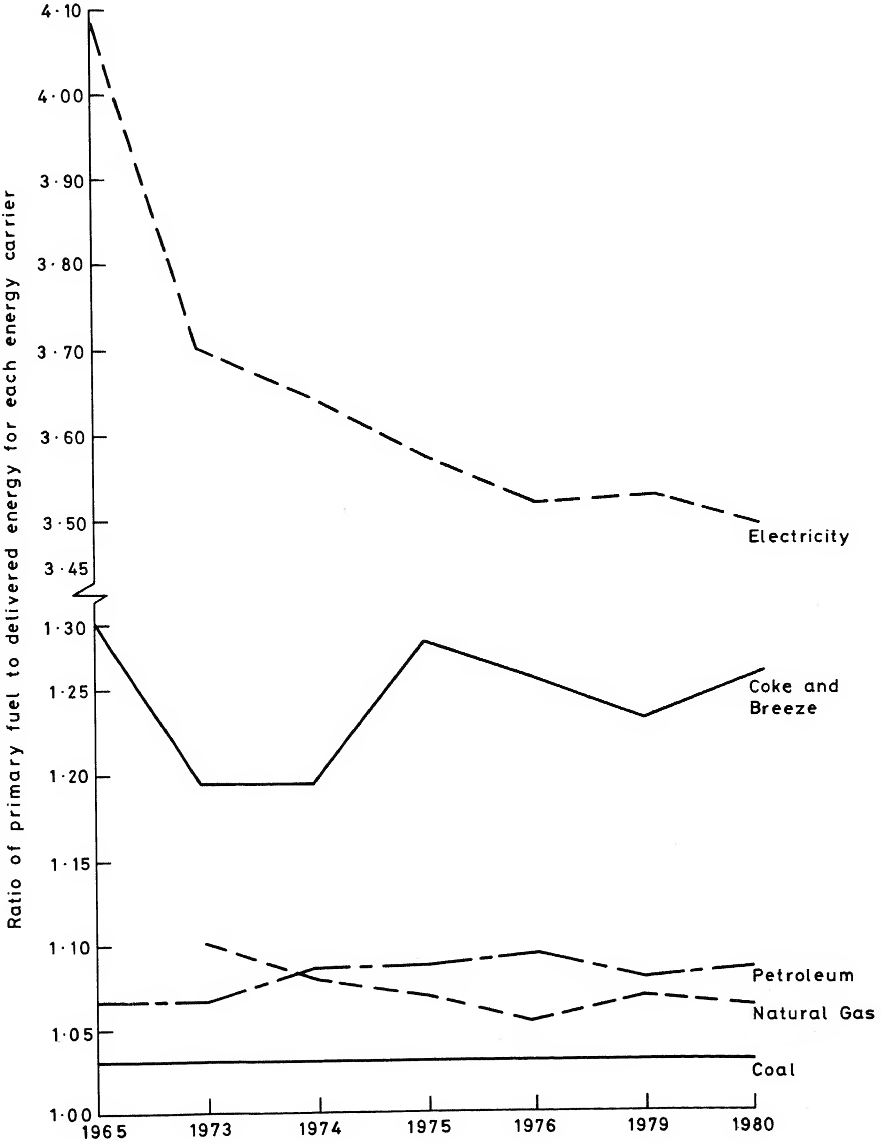
Introduction to the Calculations

20. Part I deals with the allocation of conversion and distribution losses, own use and non-conversion usage (see paragraph 11 above) as well as with international trade and stock changes in secondary fuels. As has already been stated, most of the allocations to the appropriate final consumption categories (including direct consumption) is carried out on a pro-rata basis except where mentioned otherwise. The simplified way in which allocations are carried out means that PFEs of the energy use by final consumers (after allocation) are, in fact, approximations since, with oil refineries for example, energy use in the different processes is not spread evenly over the product range. Moreover, no account has been taken of fuels used to transport solid and liquid fuels to their final consumers. Primary fuels, i.e. coal,

Table A.2 - Primary Fuel Equivalent 1980, PJ

Delivered Energy Direct Consumption		Coal	Oil	Natural Gas	Nuclear	Hydro	Total	Ratio PFE/DE
Coal	538.4	550.5	1.3	0.7	1.4	0.2	554.1	1.0292
Natural Gas	1738.1	–	–	1840.0	–	–	1840.0	1.0586
Petroleum	2615.7	5.4	2866.8	0.1	0.7	0.2	2873.2	1.0984
Coke & Breeze	166.5	207.8	0.6	0.5	0.7	0.2	209.8	1.2601
Coke Oven Gas	26.9	75.5	0.2	0.2	0.2	–	76.1	2.8290
Creosote & Pitch	1.5	1.8	–	–	–	–	1.8	1.2000
Other Solid Fuels	63.0	79.5	0.2	0.1	0.2	–	80.0	1.2698
Towns Gas	3.3	2.5	4.9	–	0.3	0.1	7.8	2.3636
Substitute Natural Gas	6.0	–	6.7	–	–	–	6.7	1.1166
Electricity	807.3	2126.0	307.3	17.0	319.4	49.0	2818.7	3.4915
Bunkers	107.3	0.2	117.8	–	–	–	118.0	1.0997
Feedstocks	167.8	0.3	183.4	–	0.1	–	183.8	1.0953
Other Non-Energy Uses	144.9	0.3	159.0	–	–	–	159.3	1.0994
TOTAL	6386.7	3049.8	3648.2	1858.6	323.0	49.7	8929.3	
Add Exports & Stock Increase								
Petroleum Products		1.3	716.9	–	0.2	–	718.4	
Coke & Breeze		82.0	0.2	0.2	0.2	–	82.6	
Other Solid Fuels		4.6	–	–	–	–	4.6	
		87.9	717.1	0.2	0.4	–	805.6	
		3137.7	4365.3	1858.8	323.4	49.7	9734.9	
Less Imports & Stock Decreases								
Petroleum Products		–	388.4	–	–	–	388.4	
Other Solid Fuels		-2.9	–	–	–	–	-2.9	
		3140.6	3976.9	1858.8	323.4	49.7	9349.4	

Figure A.1: Ratio of Primary Fuel Input to Energy Supplied



natural gas and oil are dealt with first as these are the major inputs into the secondary fuel industries.

21. Part II deals with the use of electricity in other fuel industries. Table A.2 shows the final results obtained while Figure A.1 shows the trend in Primary Fuel Equivalents for the main fuel/ energy carriers since 1965.

ANNEX A.9

PART I. The Allocation of Conversion and Distribution Losses etc.

Figure A.2 - Output of Collieries (Delivered Energy), 1980, PJ

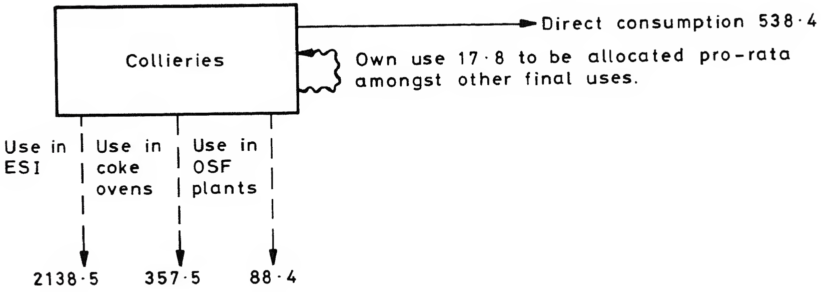
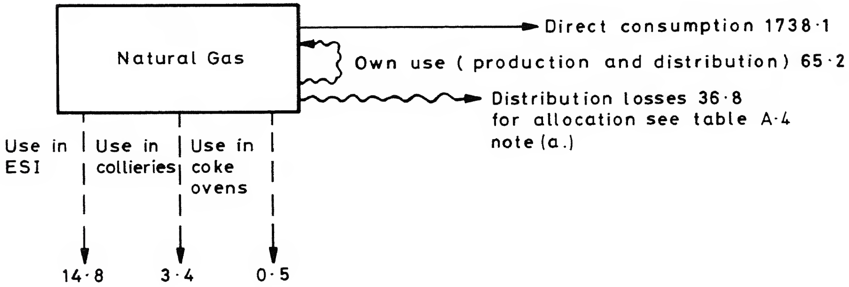


Figure A.3 - Output of Natural Gas (Excluding SNG), (Delivered Energy), 1980, PJ


Natural Gas
Direct consumption 1738·1
Own use (production and distribution) 65·2
Distribution losses 36·8 for allocation see table A·4 note (a.)
Use in ESI
Use in collieries
Use in coke ovens
14·8
3·4
0·5

ESI - Electricity Supply Industry

OSF - Other Solid Fuels

SNG - Substitute Natural Gas

ANNEX A.10

Table A.3 - Output of Collieries, (Delivered Energy), 1980, PJ

Coal	Consumption	Amount Allocated from Own Use	Consumption After Allocation of Own Use in Collieries
Direct consumption as coal	538.4	3.0	541.4
Use for electricity generation	2138.5	12.2	2150.7
Use in coke ovens	357.5	2.0	359.5
Use in OSF plants	88.4	0.6	89.0
Own use in collieries	17.8	-	-
	3140.6	17.8	3140.6

Table A.4 - Output of Natural Gas, (Delivered Energy), 1980, PJ

		Amount Allocated to Final Consumption Categories from Own Use in Production, Own Use in Distribution and Distribution Losses	Consumption After Allocation of Own Use and Distribution Losses
Direct Consumption	1738.1	101.9	1840.0
Use for Electricity Generation	14.8	0.1	14.9
Use in Collieries) Colliery	3.4	-	3.4
Use in Coke Ovens) Methane	0.5	-	0.5
Own use in production	14.1	-	-
Own use in distribution	51.1	-	-
Distribution losses	36.8	-	-
	1858.8		1858.8

(a) Own use in distribution and distribution losses allocated to direct consumption only. Own use in production allocated to all natural gas uses except colliery methane.

Figure A.4 - Petroleum Products (Delivered Energy), 1980, PJ

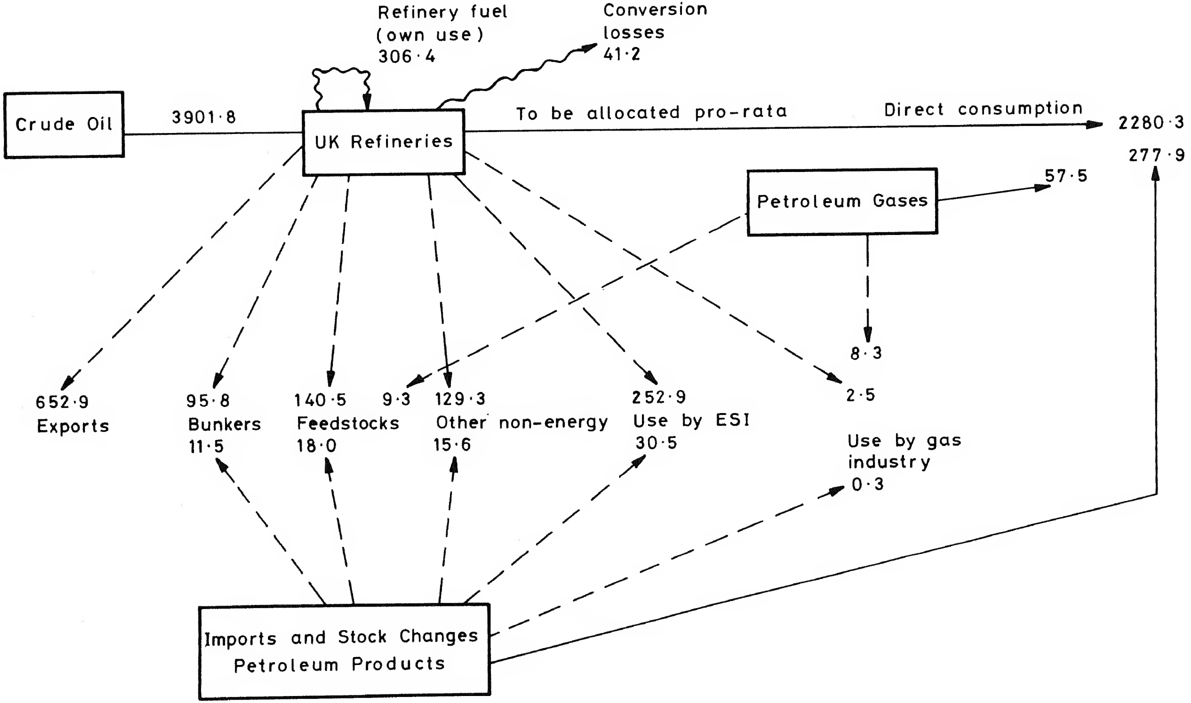


Table A.5 - Petroleum Products (Delivered Energy), 1980, PJ

A	Gross Inland Consumption of Crude Oil		
	= Refinery Input	3901.8	
	- Refinery Fuel (Own Use)	306.4	) Pro-rated) over UK) production
	- Conversion Losses	41.2	
		347.6	
	Refinery Output	3554.2	
	+ Imports and Stock Decreases	353.8	
	+ Petroleum Gases	75.1	
		428.9	
	Final Consumption	3983.1	

Table A.6 - Petroleum Products, Final Consumption (Delivered Energy), 1980, PJ

			Refinery Products by Source		Amount Allocated to Final Consumption Categories from Refinery Fuel and Conversion Losses UK Production	Amount Allocated to Imports + Ex Stock	Consumption After Pro-Rating			
	Refinery Products	PG*	UK Prodn.	Imported + Ex Stock (a)			UK Prodn.	Imports + Ex Stock	PG*	Total
Exports	652.9	-	652.9	-	63.8	-	716.7	-	-	716.7
Bunkers	107.3	-	95.8	11.5	9.4	1.1	105.2	12.6	-	117.8
Feedstocks	158.5	9.3	140.5	18.0	13.7	1.8	154.2	19.8	9.3	183.3
Other Non-Energy	144.9	-	129.3	15.6	12.6	1.5	141.9	17.1	-	159.0
Electricity Supply Industry	283.4	-	252.9	30.5	24.7	3.0	277.6	33.5	-	311.1
Gas Industry	2.8	8.3	2.5	0.3	0.2	-	2.7	0.3	8.3	11.3
Direct Consumption	2558.2	57.5	2280.3	277.9	223.2	27.2	2503.5	305.1	57.5	2866.1
	3908.0	75.1	3554.2	353.8	347.6	34.6	3901.8	388.4	75.1	4365.3

(a) It has been assumed:

- (i) that imports are spread evenly (pro-rata) over all final consumption uses
- (ii) that all exports are from 1980 UK production
- (iii) that the ratio of PFE to delivered energy for imported products is the same as for petroleum products.

* PG = Petroleum Gases

ANNEX A.14

Figure A.5 - OSF Plant Operations (Delivered Energy), 1980, PJ

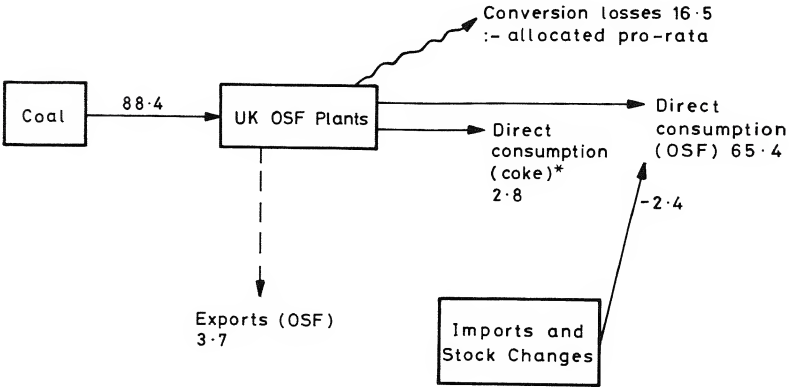
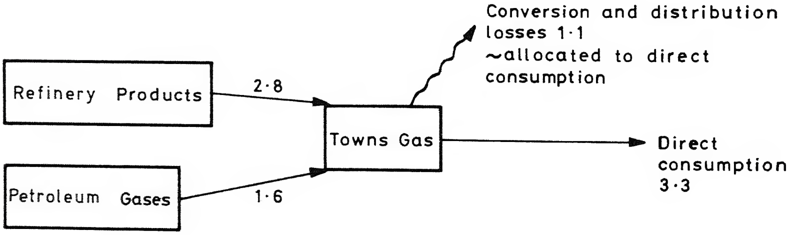


Figure A.6 - Town Gas and Substitute Natural Gas Operations (Delivered Energy), 1980, PJ

Towns Gas


Conversion and distribution losses 1·1
~allocated to direct consumption
Refinery Products
2·8
Towns Gas
Petroleum Gases
1·6
Direct consumption 3·3

Substitute Natural Gas

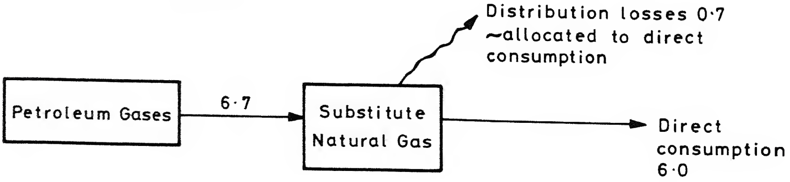


Table A.7 - Operations of Other Solid Fuel Plants, (Delivered Energy), 1980, PJ

			PFE	
A.	Input of coal	88.4		
	- Conversion losses	16.5	17.1	- Allocated pro rata over UK Production
	Output*	71.9	89.0	(from Table A.3)
	Imports and Stock Decreases	-2.4	-2.9	
	Final Consumption	69.5	86.1	

* Including coke and breeze output from other solid fuel plants.

B. Final Consumption

	Total	By Source UK Prodn.	 Imports and Stock Decreases	Amount Allocated to Final Consumption Categories from Conversion Losses PFE. UK Production	Amount Allocated to Imports and Stock Decreases
Direct Consumption (OSF)	63.0	65.4	-2.4	15.6	0.5
Direct Consumption (Coke)	2.8	2.8	-	0.7	-
Exports (OSF)	3.7	3.7	-	0.8	-
	69.5	71.9	-2.4	17.1	0.5

Amount Consumed After Pro-Rating,	Total	By Source UK Prodn.	 Imports and Stock Decreases
Direct Consumption (OSF)	78.1	81.0	-2.9
Direct Consumption (Coke)	3.5	3.5	
Exports (OSF)	4.5	4.5	-
	86.1	89.0	-2.9

Table A.8 - Town Gas and Substitute Natural Gas Operations, (Delivered Energy), 1980, PJ

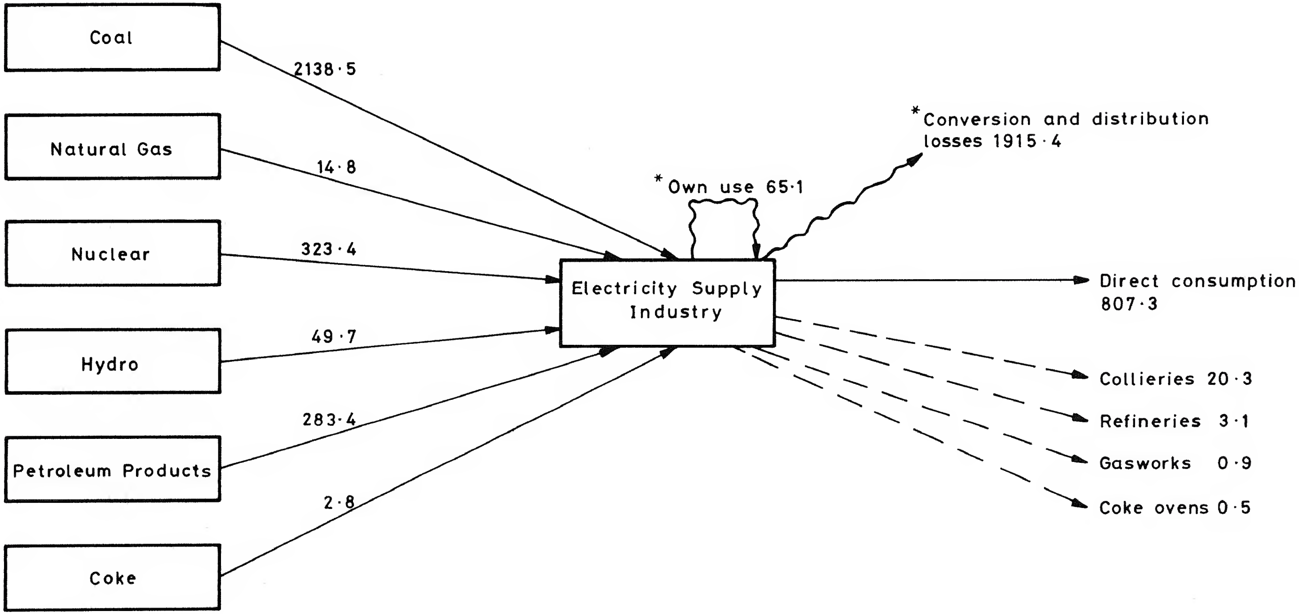
Town Gas

Fuel Inputs		Primary Fuel Equivalent
Refinery Products	2.8	3.0
Petroleum Gases	1.6	1.6
	4.4	4.6
- Conversion Losses	0.7	0.9
- Distribution Losses	0.4	0.4
	1.1	
Direct Consumption	3.3	

Substitute Natural Gas

Fuel Inputs:	Petroleum Gases	6.7
	- Distribution Losses	0.7
	Direct Consumption	6.0

Figure A.7 - Electricity Generation (Delivered Energy), 1980, PJ



* The PFEs of each of the fuel inputs are allocated to final uses of electricity pro-rata, effectively allocating conversion and distribution losses of the ESI and its own use of electricity.

ANNEX A.18

Table A.9 - Electricity Generation, (Delivered Energy), 1980, PJ

A. Fuel Inputs

		Primary Fuel Equivalent
Coal	2138.5	2150.7 (from Table A.3)
Coke	2.8	3.4 (from Table A.10)
Natural Gas	14.8	14.9 (from Table A.4)
Nuclear	323.4	323.4
Hydro	49.7	49.7
Petroleum Products	283.4	311.1 (from Table A.6)
	2812.6	2853.2
Conversion Losses	1840.1	
Distribution Losses	75.3	
Own Use	65.1 (a)	
	1980.5	
Final Consumption	832.1	

These totals are allocated pro-rata over final consumption categories as below:

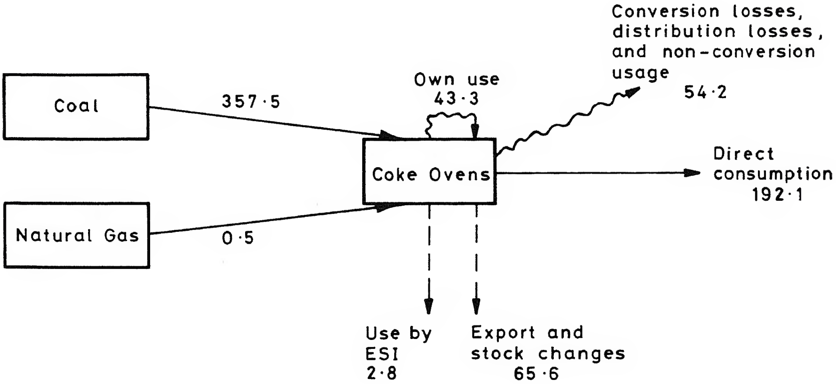
B. Final Consumption

		Primary Fuel Equivalent					
		Coal	Nat.Gas	Nuclear	Hydro	Oil	Total
Direct Consumption	807.3	2089.8	14.5	313.9	48.2	302.0	2768.4
Use in Collieries	20.3	52.4	0.3	7.9	1.2	7.5	69.3
Use in Refineries	3.1	7.9	0.1	1.1	0.2	1.1	10.4
Use in Gasworks	0.9	2.5	-	0.3	0.1	0.3	3.2
Use in Coke Ovens	0.5	1.5	-	0.2	-	0.2	1.9
	832.1	2154.1*	14.9	323.4	49.7	311.1	2853.2

(a) = 69.6 PJ - 4.5 PJ other secondary industries. Electricity use in refineries, gasworks and coke ovens is dealt with in part II.

* = 2150.7 PJ (PFE coal) + 3.4 PJ (PFE coke)

Figure A.8 - Coke Oven Operations (Delivered Energy), 1980, PJ



Notes

(1) For the purpose of the calculation of the PFE of delivered energy, all coke ovens, whether in the iron and steel industry or not, have been regarded as a secondary fuel industry which produces coke, breeze, coke oven gas and creosote/pitch mixtures.

(2) Allocations of conversion losses, distribution losses and own use as follows:

Conversion Losses - allocated pro-rata amongst coke and breeze, coke oven gas and creosote and pitch.

Distribution Losses - 1.9 PJ coke and breeze, 3.6 PJ coke oven gas, 0.1 PJ allocated pro-rata (to coke oven gas).

Own Use - 5.0 PJ coke and breeze, 38.4 PJ coke oven gas, 0.8 PJ allocated pro-rata (0.7 PJ to coke oven gas, 0.1 PJ to coke and breeze).

(3) The PFE of coke and breeze is allocated over final uses pro-rata.

Table A.10 - Coke Oven Operations, (Delivered Energy), 1980, PJ

A. Fuel Inputs

		Primary Fuel Equivalent
Coal (including non-conversion usage)	357.5	359.5 (Table A.3)
Methane	0.5	0.5 (Table A.4)
	358.0	360.0 = PFE of Final Consumption
- Conversion Losses (+ non-conversion usage)	48.7	49.7
Distribution Losses	5.5	5.6
Own Use	43.3	44.2
	97.5	99.5
Final Consumption	260.5 (= 232.1 Coke + Breeze, 26.9 Coke Oven Gas; 1.5 Creosote + Pitch)	360.0 (= 284.2 Coke + Breeze; 74.0 Coke Oven Gas; 1.8 Creosote + Pitch) For details of allocation see Figure A.8 Note (2).

B. Final Consumption

	Total	Amount Allocated to Final Consumption Categories from Conversion Losses, Distribution Losses and Own Use (PFE)	Total After Allocation Processes Described in Note (2), Figure A.8	Primary Fuel Equivalent**	
				Coal	Methane
Direct Consumption:					
Coke and Breeze	163.7	36.7	200.4	200.1	0.3
Coke Oven Gas	26.9	47.1	74.0	73.9	0.1
Creosote and Pitch	1.5	0.3	1.8	1.8	-
* Use by ESI	2.8	0.6	3.4	3.4	-
* Exports and Stock Increases	65.6	14.8	80.4	80.3	0.1
	260.5	99.5	360.0	359.5	0.5

* All coke and breeze.

** Derived after the total PFE figures had been calculated.

Figure A.9 - Allocation and Reallocation of Energy Use in Collieries (Primary Fuel Equivalent), 1980, PJ

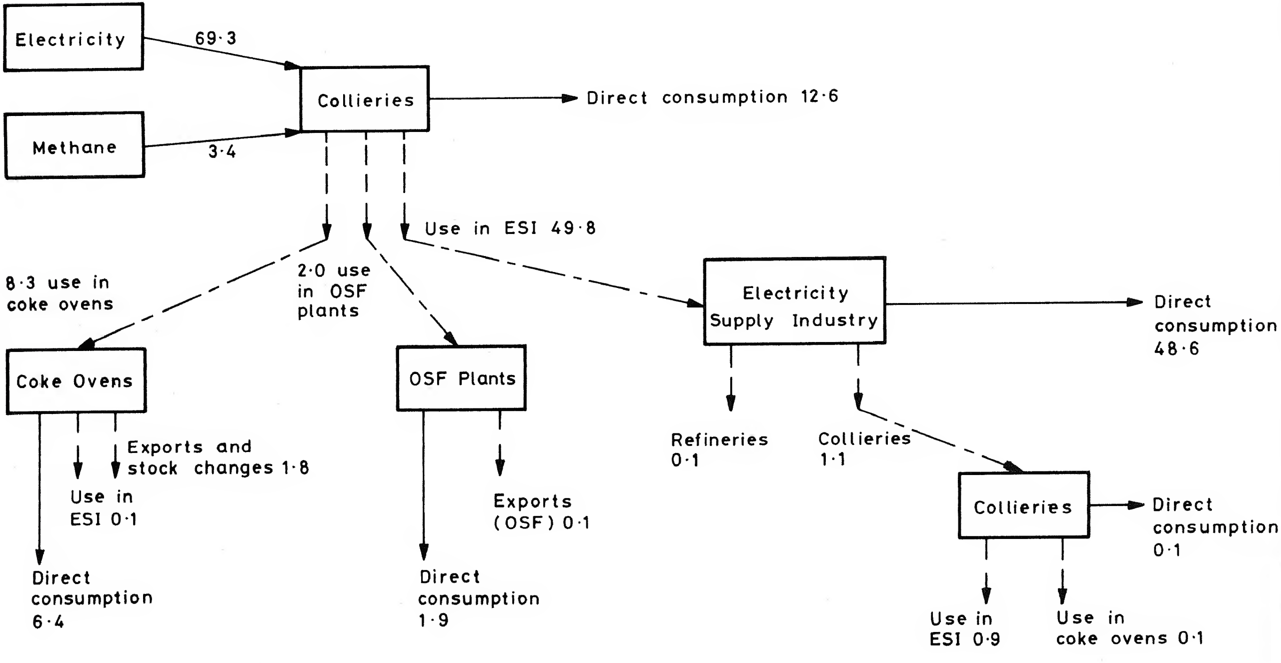


Table A.11 - Use of Electricity in Collieries, 1980, PJ

	Primary Fuel Equivalent					
	Total	Coal	Oil	Natural Gas	Nuclear	Hydro
Use of electricity (d)	69.3	52.4	7.5	0.3	7.9	1.2
Use of methane (e)	3.4	-	-	3.4	-	-
	72.7	52.4	7.5	3.7	7.9	1.2
Attributable to:						
Direct consumption	12.6	9.0	1.3	0.7	1.4	0.2
Electricity generation	49.8	35.9	5.2	2.5	5.4	0.8
Use in coke ovens	8.3	6.0	0.8	0.4	0.9	0.2
Use in OSF plants	2.0	1.5	0.2	0.1	0.2	-
	72.7	52.4	7.5	3.7	7.9	1.2
(i) First reallocation of energy supplied for electricity generation:						
Direct consumption	48.6	34.9	5.1	2.5	5.3	0.8
Use in collieries	1.1	0.9	0.1	-	0.1	-
Use in refineries	0.1(b)	0.1	-	-	-	-
	49.8	35.9	5.2	2.5	5.4	0.8
(ii) Second reallocation of use in collieries:						
Direct consumption	0.1	0.1	-	-	-	-
Electricity generation	0.9(a)	0.7	0.1	-	0.1	-
Use in coke ovens	0.1(c)	0.1	-	-	-	-
	1.1	0.9	0.1	-	0.1	-
(iii) First reallocation of coke oven usage:						
Direct consumption						
Coke and breeze	4.5	3.2	0.4	0.2	0.5	0.2
Coke oven gas	1.8	1.3	0.2	0.1	0.2	-
Use by ESI	0.1(b)	0.1	-	-	-	-
Exports and stock increases	1.9	1.4	0.2	0.1	0.2	-
	8.3	6.0	0.8	0.4	0.9	0.2
(iv) First reallocation of OSF plant usage:						
Direct consumption (OSF)	1.9	1.4	0.2	0.1	0.2	-
Exports (OSF)	0.1	0.1	-	-	-	-
	2.0	1.5	0.2	0.1	0.2	-

(a) Second reallocation of energy supplied for electricity generation: all attributed to direct consumption.

(b) Attributed to direct consumption.

(c) Attributed to direct consumptions of coke and breeze.

(d) From Table A.9.

(e) From Table A.4.

Table A.12 - Use of Electricity in Other Fuel Industries, (Delivered Energy), 1980, PJ

REFINERIES	Primary Fuel Equivalent					
	Total	Coal	Oil	Natural Gas	Nuclear	Hydro
Use of electricity (c)	10.4	7.9	1.1	0.1	1.1	0.2
Attributable to:						
Direct consumption	7.0	5.3	0.7	0.1	0.7	0.2
Exports	1.7	1.3	0.2	-	0.2	-
Bunkers	0.2	0.2	-	-	-	-
Feedstocks	0.5	0.3	0.1	-	0.1	-
Other non-energy	0.3	0.3	-	-	-	-
Electricity generation	0.7(a)	0.5	0.1	-	0.1	-
	10.4	7.9	1.1	0.1	1.1	0.2
COKE OVENS						
Use of electricity (c)	1.9	1.5	0.2	-	0.2	-
Attributable to:						
Direct consumption						
Coke and breeze	1.3	0.9	0.2	-	0.2	-
Coke oven gas	0.3	0.3	-	-	-	-
Exports and stock increases	0.3	0.3	-	-	-	-
	1.9	1.5	0.2	-	0.2	-
TOWN GASWORKS						
Use of electricity (c)	3.2(b)	2.5	0.3	-	0.3	0.1

(a) Attributable to direct consumption.

(b) Attributable to direct consumption.

(c) From Table A.9.

INDEX

Abrasives industries, 80, 81.
Agriculture, 3, 5, 19, A1.
Air conditioning, 14, 15, 16, 17, 18.
Air transport, 5, 109, 110, 111.
Allied chemicals trades, 26, 31, 97-101.
Alloys manufacturing, 56.
Aluminium, 56, 57, 60.
Aluminium alloys industries, 56, 60.
Ammonia, 39, 97.
Annealing lehrs, 89.
Annual Abstract of Statistics, 12.
Appliances, energy used in
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 96.
  chemical and allied trades, 101.
  china, earthenware and glass, 90-92.
  commercial and institutional buildings, 13-18.
  domestic sector, 3, 9.
  electricity used in, 6.
  engineering and other metal trades, 49-55, 59-63.
  food, drink and tobacco industries, 32, 37-45.
  iron and steel industry, 24, 25.
  other industries, 29.
  paper, printing and stationery, 74, 77-79.
  textiles, leather and clothing, 67-73.
  UK total, 5.
Asbestos products, 30.
Aviation fuels, 110, 111.

Bakers, 66.
Bakery products, 33, 35, 40.
Basic oxygen, 23, 24, 25.
Biscuits subsector, 35.
Bitumen coated products, 80.
Blanching, 35.
Blankets, 9.
Blast furnace gas, 22, 23.
Blast furnaces, 22, 24, 25.
Blending, 35.
Board products, 75, 78.
Boilers, energy used in,
  bricks, tiles, fireclay and other building materials, 83, 86.
Boilers, energy used in,
  cement industry, 96.
  chemical and allied trades, 100, 101.
  china, earthenware and glass, 90, 92.
  engineering and other metal trades, 49, 50, 52-55, 63.
  food, drink and tobacco, 32, 37-44.
  iron and steel industry, 23.
  other industry, 29, 31.
  other trades, 105, 107, 108.
  paper, printing and publishing, 74-79.
  textiles, leather and clothing, 65, 67-73.
  UK total, 5.
Bread and flour confectionery subsector, 35.
Brewing industries, 36.
Bricks industry, 26, 31, 80-86.
British Ceramics Manufacturers Research Association, 80, 89.
British Gas, 11.
British Glass Industry Research Association, 89.
Building products, 80, 81, 86.
Building stock, 11.
Burning oil, 9, 10.
Butane, 9, 10.

Calcining, 80, 93, 94, 100.
Calcium aluminate, 94.
Calcium aluminoferrite, 94.
Calcium silicate, 94.
Carpets, 64, 70.
Cars, 109, 110, 111.
Catering, 13, 14, 15, 16, 17, 18.
CEGB, 11, 12.
Cement industry, 26, 31, 93-96.
Central heating, 9, 10.
Central steam/hot water systems,
  bricks, tiles, fireclay and other building materials, 83, 86.
  chemical and allied trades, 101.
  china, earthenware and glass, 90-92.
  engineering and other metal trades, 47, 49-55, 59-63.
  food, drink and tobacco, 32, 35, 37-45.
  other industry, 29, 31.
  other trades, 105-108.

Central steam/hot water systems,
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 65, 67-74.
Chemicals industry, 26, 31, 97-101.
China industry, 26, 31, 87-92.
CHP, combined heat and power,
  chemical and allied trades, 97, 101.
  engineering and other metal trades, 49, 54, 63.
  food, drink and tobacco, 32, 35, 37, 41-44.
  iron and steel industry, 24, 25.
  other industry, 31, 32.
  other trades, 105.
  paper, printing and publishing, 77, 78.
  textiles, leather and clothing, 67, 71, 74.
  UK, energy use in, 5.
Cleaning, 65, 66.
Clinker, 94, 95.
Clothing industries, 26, 31, 64-73.
Clubs, 12, 13, 18.
Coal, 2.
  agriculture, 19.
  bricks, tiles, fireclay and other building materials, 82.
  cement, 94.
  chemicals and allied trades, 99.
  china, earthenware and glass, 88.
  coke oven operations, A19, A20, A23.
  collieries, A22.
  commercial and institutional buildings, 11.
  domestic sector, 7.
  energy industries, A4.
  engineering and other metal trades, 47, 57.
  ESI, A17, A18.
  food, drink and tobacco, 34.
  iron and steel industry, 20-22, 24, 25.
  OSF plants, A14, A15.
  other industry, 28.
  other trades, 102.
  paper, printing and publishing, 76.
Coal,
  primary fuel equivalent, A1, A2, A7, A8.
  refineries, A23.
  textiles, leather and clothing, 65.
  towns gas works, A23.
  UK total use, 3, 5.
Coke and breeze, use in,
  agriculture, 19.
  bricks, tiles, fireclay and other building materials, 82.
  cement, 94.
  chemicals and allied trades, 99.
  china, earthenware and glass, 88.
  coke oven operations, A19, A20, A23.
  collieries, A22.
  commercial and institutional buildings, 11.
  domestic sector, 7.
  engineering and other metal trades, 57.
  food, drink and tobacco, 34.
  iron and steel industry, 20-22.
  OSF plants, A14, A15.
  other industry, 28.
  other trades, 102.
  paper, printing and publishing, 76.
  primary fuel equivalent, A2, A3, A5, A7, A8.
  textiles, leather and clothing, 65.
  UK total use, 3, 5.
Coke oven gas, energy use in,
  chemicals and allied trades, 99.
  china, earthenware and glass, 88, 89.
  coke oven operations A19, A20, A23.
  engineering and other metal trades, 57.
  iron and steel industry, 20, 21, 23.
  other industry, 28.
  primary fuel equivalent, A2, A5, A7.
Coke ovens, 22, 23, A2, A3, A9, A10, A17-A23.
Cold rolling, 23.
Collieries, A2, A4, A10, A17, A18, A21, A22.

Commercial and institutional
  buildings, 3, 5, 11-18.
Commercial buildings, 13, 16, 18.
Commercial offices, 12, 18.
Compressed air, 66.
Compressors, 29, 48, 100.
Concentration, 35.
Conical barred shells, 74.
Construction industry, 29, 102,
  103, 108.
Converting mills, 74.
Conveyors, 29.
Cooking, 5, 6, 8, 9, 13, 14, 15,
  16, 17, 18, 35.
Cooling, 47.
Copper, 56, 58, 61.

Dairy industry, 33, 35, 38.
Defence establishments, 12, 17.
Delivered energy, 1.
Department of Transport, 29.
Detergents, 98.
Derv, 109.
Digest of UK Energy Statistics, 1,
  3, 9, 12, 19, 20, 22, 26, 29, 30,
  80, 87, A3.
Direct acting space heaters, 9,
  10.
  acting water heaters, 10.
  process energy, see process
  energy.
Dishwashers, 9.
Domestic sector, 3, 5, 7-10, A1.
Drink industries, 26, 31, 33-45.
Dry process, 93.
Dryers, 35, 74.
Drying, 35, 47, 65, 66, 80, 89, 94,
  104.
Dyeing, 66.
Dyestuffs, 98.

Earthenware industry, 26, 31,
  87-92.
Education, 12, 17.
Efficiency, 1.
Electric arc furnaces, 23-25.
Electric machinery, 5, 19.
Electric traction, 6.
Electric Vehicle Association, 29.
Electrical ceramics, 87.
Electrical engineering, 46-48, 52.
Electricity, use in,
  agriculture, 19.

Electricity, use in,
  bricks, tiles, fireclay and other
  building materials, 83-86.
  cement, 94-96.
  chemicals and allied trades, 99.
  china, earthenware and glass, 86,
  88, 90-92.
  collieries, A21, A22.
  commercial and institutional
  buildings, 10, 11, 13-19.
  domestic sector, 7-10.
  engineering and other metal
  trades, 47-55, 57, 59, 60, 62,
  63.
  ESI, A17, A18.
  food, drink and tobacco, 34,
  36-45.
  iron and steel industry, 20, 21,
  23-25.
  other industry, 28, 29, 32.
  other trades, 103-107.
  paper, printing and publishing,
  74, 76-79.
  primary fuel equivalent, A2, A4,
  A7, A8.
  refineries, A23.
  textiles, leather and clothing,
  65-73.
  transport, 109-111.
  UK, total use in, 3-6.
Electricity Council, 9, 11, 12.
Electrochemical processes, 6, 29,
  57, 59, 60-63, 100, 101.
End use, 4, 5.
Energy demand, 4.
Energy industries, 2.
Engineering industries, 26, 31,
  46-55, 63.
ESI, electricity supply industry,
  A9, A11, A13, A17, A19, A21,
  A22.
ETSU, 1, 19, 29, 102.
Evaporation, 35.
Extraction industries, 102.
Extrusion, 57.

Galvanising, 58.
Gas industry, A11, A13, A17.
Gas/diesel oil, 10, 13, 23, 29, 82,
  109-111.
Gases, natural gas and towns gas,
  energy use in,
  bricks, tiles, fireclay and
  other building materials, 83-86.

Gases, natural gas and towns gas, energy use in,
  cement, 94, 96.
  china, earthenware and glass, 90-92.
  commercial and institutional buildings, 13-18.
  domestic sector, 8-10.
  engineering and other metal trades, 49-55, 59, 63.
  food, drink and tobacco, 37-45.
  iron and steel industry, 24, 25.
  other industry, 32.
  other trades, 105-107.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 67-73.
  UK total use, 4, 5.
Glass containers, 87.
Glass industry, 26, 31, 87-92.
Goods vehicles, 109-111.
Grain milling subsector, 35.

Health, 12, 17.
Heat treatment, 48.
Heated clothes driers, 9.
Heating and drying units, 5, 19.
Heavy fuel oil, 13.
High temperature heat, 5, 100.
  treatment, 47.
Hot water, 65.
  see Central steam/hot water.
Hotels, 12, 18.
Household tissues, 75.
Hydroelectricity, A1, A7, A17, A18.

Industrial paper, 75.
Industry sector, 3, 26-32, A1.
Ingot casting, 24, 25.
Inorganic chemicals, 97, 98.
Institutional buildings, 13, 15, 17.
Instrumental engineering, 46, 48, 51.
Integrated steelworks, 22.
International trade, 2, A5.
Iron and steel industry, 1, 3, 5, 20-25, A1.
Iron castings, 24, 25.
Iron making, 5, 24, 25.
Irons, 9.

Jewellery, 48.
Jute, 64, 70.

Kettles, 9.
Kilning, 80.
Kilns, 35, 80, 88, 89, 94, 100, 104.
Knitted goods, 64, 70.

Laundries, 102.
Lead industry, 56, 62.
Leather goods industry, 64, 66, 72.
Leather industries, 26, 31, 64-73.
Lighting, energy used in,
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 96.
  chemicals and allied trades, 101.
  china, earthenware and glass, 90-92.
  commercial and institutional buildings, 13-18.
  domestic sector, 8.
  electricity used in, 6.
  engineering and other metal trades, 49-55, 59-63.
  food, drink and tobacco, 32, 37-45.
  iron and steel industry, 24, 25.
  other industries, 29.
  other trades, 105-107.
  paper, printing and publishing, 74, 77-79.
  textiles, leather and clothing, 67-73.
  UK total use in, 5.
Liquid natural gas, 97.
Liquid nitrogen, 39.
Liquid petroleum gases, LPG, 5, 23, 47, 82, 89, 97, A11, A12, A14, A16.
Liquids, oil + LPG energy use in,
  agriculture, 19.
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 94, 96.
  china, earthenware and glass, 90-92.
  commercial and institutional buildings, 13-18.
  domestic sector, 8, 9.

Liquids, oil + LPG energy use in,
  engineering and other metal trades, 49-55, 59-63.
  food, drink and tobacco, 37-45.
  iron and steel industry, 23-25.
  other industry, 32.
  other trades, 105-107.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 67-73.
  transport, 110.
  UK total use in, 4, 5.
London Transport, 109.
Low temperature heat, 6.
Lubricants, A1.

Malting industries, 35, 36.
Man-made fibres, 64-66, 71.
Marine bunkers, 109, 100,
  see Ship's bunkers.
Marine engineering, 46, 48, 53.
Materials preparation, 80.
Mechanical engineering, 46, 48, 50.
Melting, 57, 80, 89.
Metal finishing, 5, 23-25.
Metal shaping, 23.
Methane, A4, A10, A20-A22.
Methanol, 97.
Mining, 102.
Miscellaneous chemicals, 98.
  foods, 33, 35, 36, 44.
  textiles, 64, 66, 70.
  sector, 3.
Mixing, 35.
Motive power, energy use in,
  agriculture.

Naphtha, 97.
National and Local Government buildings, 12, 17.
Natural gas, energy use in,
  bricks, tiles, fireclay and other building materials, 32.
  cement, 94.
  chemicals and allied trades, 99.
  china, earthenware and glass, 88, 89.
  coke oven operations, A19.
  collieries, A22.
  commercial and institutional buildings, 11.
  domestic sector, 7.
Natural gas, energy use in,
  engineering and other metal trades, 57.
  ESI, A17, A18.
  food, drink and tobacco, 34.
  iron and steel industry, 20, 21.
  other industry, 28.
  paper, printing and publishing, 76.
  primary fuel equivalent, A2, A3, A7.
  textiles, leather and clothing, 65.
  UK total use in, 2, 3, 5.
Natural gas feedstocks, 6, 97.
Newsprint, 75.
Nickel, 58.
Non-ferrous metals, 56, 62.
  -heat uses of electricity, 6, 74.
  -process energy use, 24, 25, A7, A11, A13, A23.
  -refinery use, 5, 6.
Nuclear electricity, A1, A3, A7, A17, A18, A22.

Off-peak electricity, 8, 14-18.
Off road vehicles, energy use in,
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 96.
  chemicals and allied trades, 101.
  china, earthenware and glass, 86, 90, 92.
  engineering and other metal trades, 49, 50, 52, 54, 55, 59-63.
  food, drink and tobacco, 37-44.
  other industry, 29, 32.
  other trades, 103, 105, 107, 108.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 67, 69-71.
  UK total energy use in, 6.
Oils and fats industries, 33, 35, 36, 43.
Ore reduction, 100.
Organic chemicals, 97-99.
OSF plants, Other Solid Fuel plants, A2, A9, A10, A14, A15, A21, A22.

Other building materials, 26, 31, 80-86.
  end uses, 5.
  final consumers, 3.
  glass products, 87.
  industries, 3, 5, 28-32.
  manufacturing industries, 102, 108.
  metal manufacture, 46-48, 55.
  metal trades, 26, 31, 46, 56-63.
  premises, 12, 18.
  process energy uses, 5.
  solid fuel, OSF, 3, 5, 7, 11, 103, A2, A7, A17, A18, A22.
  trades, 26, 31, 102-106.
  vehicles, 110, 111.
Ovens, 35, 66.
Oxygen production, 24, 25.

Packaging material, 74, 75.
Paints, 97, 98.
Paper industry, 26, 31, 74-79.
Paper mills, 74.
Pasteurisation, 35.
Peeling, 35.
Pesticides, 97.
Petroleum and petroleum products, energy use in,
  agriculture, 19.
  bricks, tiles, fireclay and other building products, 82.
  cement, 94.
  chemicals and allied trades, 99.
  china, earthenware and glass, 88.
  commercial and institutional buildings, 11.
  domestic sector, 7.
  engineering and other metal trades, 47, 57.
  ESI, A17, A18.
  food, drink and tobacco, 34.
  iron and steel industry, 20, 21.
  OSF plants, A14.
  other industry, 28.
  other trades, 103.
  paper, printing and publishing, 76.
  primary fuel equivalent, A2, A5, A7, A8.
  refineries, A11-A13.
  SNG operations, A14, A16.
  textiles, leather and clothing, 65.
Petroleum and petroleum products, energy use in,
  towns gas works, A14, A16.
  UK total use, 3, 5.
Petroleum feedstocks, 97, A1.
Petroleum industry, 3, 5.
Pharmaceuticals, 98.
Plastics manufacture, 102, 104, 106.
Polymers, 98.
Post-finishing operations, 24, 25.
Pottery, 88, 89.
Power units, 5, 19.
Precious metals, 46.
Primary finishing operations, 23, 24, 25.
Primary fuel, 2, A1.
Primary fuel equivalent, 2, 3, A1, A4, A5, A7, A17-A21.
Printing industry, 26, 31, 74-79.
Private generation, energy use,
  chemicals and allied trades, 97.
  engineering and other metal trades, 49, 54, 59, 60-62.
  food, drink and tobacco, 36, 37, 41-44.
  iron and steel industry, 23-25.
  other industry, 31, 32.
  other trades, 105, 108, 110.
  paper, printing and publishing, 77, 78.
  textile, leather and clothing, 67, 71.
  transport, 11.
  UK total use, 5.
Process energy or direct process energy, energy use in,
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 96.
  chemicals and allied trades, 100, 101.
  china, earthenware and glass, 86, 89-92.
  engineering and other metal trades, 49-55, 58-63.
  food, drink and tobacco, 35, 37-45.
  other industry, 31, 32.
  other trades, 105-108.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 65-73.

Process energy or direct process energy, energy use in,
  UK total use in, 5, 6.
Processed foods, 33, 35, 39.
Propane, 9, 10.
Public administration, 15, 17, A1.
  administration and miscellaneous sector, 11, A1.
  houses, 12, 13, 18.
  lighting, 12, 14, 15.
Publishing, 74, 76, 78.
Pulp cleaning, 74.
Pulping, 74.
Pumps, 100.

Quarrying, 102.

Radios, 9.
Rail transport, 5, 109, 110.
Railways, 109-111.
Refineries, A2, A11-A13, A17, A18, A21.
Refining, 58, 74.
Refractories, 80, 81, 85.
Refrigerant, 39.
Refrigeration plant, 35, 37-43.
Refrigerators, 9.
Reheating furnaces, 23.
Restaurants, 12, 18.
Road transport, 5, 109, 110.
  vehicles, 109.
Rolling, 57.
Rubber manufacture, 102, 104, 106.

Sanitaryware, 87, 88.
Secondary finishing operations, 23-25.
  refining, 57.
Semi dry process, 93.
  fabrication, 57, 58.
  wet process, 93.
Shafts, 29.
Shaping, 80.
Ship-building, 46, 48, 53.
Ship's bunkers, 6, 109, A1, A7, A11, A13, A23, see Marine bunkers.
Shops, 12, 18.
Sinter plant, 22.
Smelting, 57, 58.
SNG, 3, A2, A7, A14, A16.
Soaking pits, 23.
Solid Fuels Advisory Service, 9.
Solids and solid fuels, energy use in,
  agriculture, 19.
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 96.
  chemicals and allied, 99.
  china, earthenware and glass, 86-90, 91.
  commercial and institutional buildings, 10, 13-19.
  domestic sector, 8-10.
  engineering and other metal trades, 105-107.
  food, drink and tobacco, 37-44.
  iron and steel industry, 24, 25.
  other industry, 32.
  other trades, 105-107.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 67-73.
  transport sector, 110, 111.
  UK total use in, 4, 5.
Space heating, energy use in,
  bricks, tiles, fireclay and other building materials, 83-86.
  cement, 94, 96.
  chemicals and allied trades, 100, 101.
  commercial and institutional buildings, 10, 13-18.
  domestic sector, 8-10.
  engineering and other metal trades, 48-55, 59-63.
  food, drink and tobacco, 35, 37-45.
  iron and steel industry, 24, 25.
  other industry, 31, 32.
  other trades, 103, 105-108.
  paper, printing and publishing, 77-79.
  textiles, leather and clothing, 65-73.
  UK total use in, 5, 6.
Special paper, 75.
Stationary industry, 26, 31, 74-79.
Stationary motive power, see motive power.
Steam, energy use in,
  chemicals and allied trades, 100.

Steam, energy use in,
  engineering and other metal trades, 49, 54, 63.
  food, drink and tobacco, 35-44.
  iron and steel industry, 34, 35.
  other industry, 32.
  other trades, 105.
  paper, printing and publishing, 74, 77, 78.
  textiles, leather and clothing, 65-67, 71.
Steel making, 5, 24, 25.
Stenters, 66.
Sterilisation, 35.
Stills, 35.
Stock changes, A5, A7, A11, A12, A14, A15, A19, A23.
Sugar and sugar products, 33, 35, 36, 41.
Sundries, 9.

Taxis, 110, 111.
Television sets, 9.
Textile finishing, 64, 65, 70.
Textile industries, 26, 31, 64-73.
Tile industries, 26, 31, 80-86.
Tiles, 87.
Timber, 102, 104, 107.
Tin, 58.
Tobacco industries, 26, 31, 33-45.
Towns gas, 3, 5, 7, 11, 47, 99, A2, A7.
  gasworks, A2, A14, A16-A18, A23.
Tractors, 19.
Transport fuels, 6, 109-111.
Transport sector, 3, 5, 109-111.

UK Digest of Energy Statistics, see Digest ...
Unrestricted electricity, 14-18.
Useful heat, 1, 2.

Vacuum cleaners, 9.
Vegetable and meat industries, 35.
Vehicles manufacture, 46-48, 54.

Washing, 66.
  machines, 9.
Waste heat, 80, 99.
  treatment, 74.
Water heating,
  supply, 102.
  transport, 5, 109-111.
Welding, 48.
Wet process, 93.
Wholesale wharehouses, 12, 16.
Wood waste, 104, 107.
Woollen industry, 64, 66, 68.
Working,
  of other non-metallic minerals, 81.
  of stone, 80, 81.
Worsted industry, 64, 66, 68.
Wrapping paper, 75.
Writing paper, 75.

Zinc, 56, 58, 62.

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